WATER MANAGEMENT, EROSION AND SEDIMENT CONTROL FOR CONSTRUCTION AREAS

TECHNICAL STANDARD AND SPECIFICATION

Diversion (D)

(Temporary and Permanent)

Definition

An earth channel with supporting ridge on the lower side constructed across the slope.

Scope

This standard covers the installation of diversions on construction sites and urban developments.

It includes temporary diversions, interceptors and diversion dikes as well as permanent diversions and level spreaders. Temporary diversions usually have a life expectancy of one year or less, and the failure hazard is low.

Purpose

The purpose of this practice may include:

1) To divert storm runoff away from unprotected slopes to a stabilized outlet.

2) To divert sediment-laden runoff from a disturbed area to a sediment basin.

3) To shorten the flow length within a long, sloping drainage area.

Conditions Where Practice Applies

This practice applies to sites where runoff from higher lying areas is damaging (1) low lying areas, (2) cut or fill slopes or steeply sloping land, (3) critical sediment source areas in construction sites, (4) buildings and residences, and (5) active gullies or other erodible areas.

Diversions must have stable outlets. The combination of conditions of site, slopes and soils should be so that the diversion can be maintained throughout its planned life.

Diversions are not recommended below high sediment-producing areas unless land treatment practices or structural measures, designed to prevent damaging accumulations of sediment in the channels, are installed with or before the diversions.

Diversion (D) (Temporary and Permanent) (Cont'd)

Design Criteria

Capacity

Runoff will be computed by the method outlined in Chapter 2, SCS Engineering Field Manual for Conservation Practices or by other acceptable methods. Runoff computations will be based upon the most severe soil and cover conditions that will exist in the area above the diversion during the planned life of the structure.

The minimum design 24-hour storm frequencies and freeboard will comply with Table 1. In all cases, the design storm frequency should be chosen to provide protection that is compatible with hazard or damage that would occur if the diversion should overtop.

Table 1 - Design Frequencies and Freeboard

DIVERSION TYPE	TYPICAL AREA OF PROTECTION	DESIGN FREQUENCY	FREEBOARD REQUIRED
Temporary	Construction Areas (roads, pipelines, etc.)	2 years	0.0
	Building Sites	5 years	0.0
Permanent	Land Areas, Play Fields, Recreation Areas, etc.	10 years	0.3 ft.
	Homes, Schools, Industrial Buildings, etc.	25 years	0.5 ft.

Design Velocity

Diversions should be designed so that the design velocities are as high as will be safe for the planned type of protective vegetation and the expected maintenance. Maximum permissible velocities are dependent upon (1) the erosion resistance of the soil in that the diversion is constructed and (2) the quality of the vegetation established and maintained in the diversion channel.

Diversion (D) (Temporary and Permanent) (Cont'd)

The maximum allowable velocities for diversions are listed in Table 2.

Table 2 - Permissible Velocities

Soil Texture	Bare Channel	Allowable Velocity (v) in Ft/Sec Condition of Vegetation Poor	Fair	Good
Sand, silt, sandy loam, silt loam	1.5	1.5	2.0	3.0
Silty clay loam, sandy clay loam	2.0	3.0	4.0	5.0
Clay	2.5	3.0	5.0	6.0

Cross Section

A typical diversion cross section consists of a channel and a supporting ridge. In the case of an excavated-type diversion, the natural ground serves as the diversion ridge. Diversion cross sections must be adapted to the equipment that will be used for their construction and maintenance.

The channel may be parabolic or trapezoidal in shape. The use of "V" channels is generally discouraged due to erosion problems experienced in the channel.

The diversion shall be designed to have stable side slopes no steeper than 3:1. The ridge shall have a minimum top width of 4 feet at the design flow depth. Ridge height shall include design flow depth, freeboard (Table 1), and a minimum settlement factor of 10 percent.

Diversion (D) (Temporary and Permanent) (Cont'd)

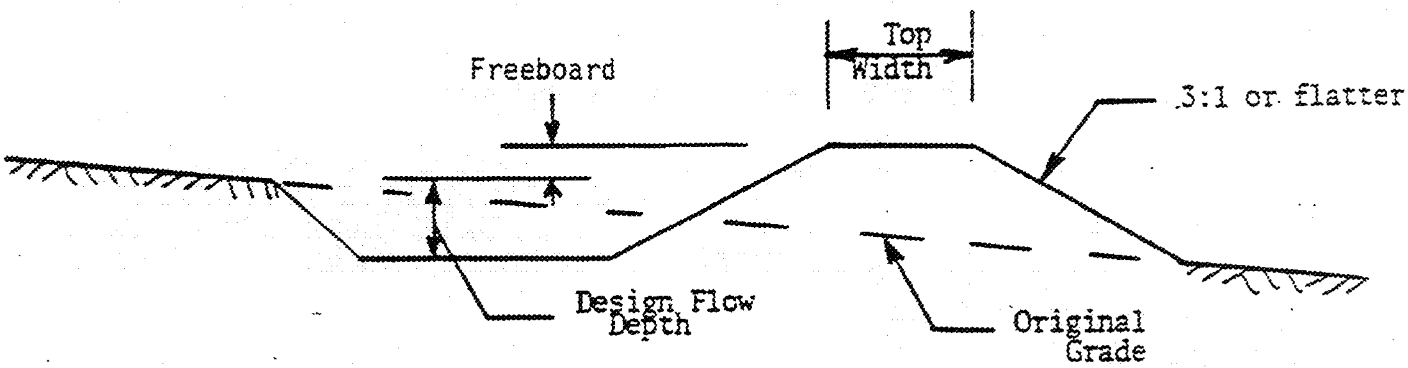


Figure 1

Cross Section of a Permanent Diversion

Channel Dimensions

Channel dimensions will be determined using the appropriate retardance factor or by Manning's formula using a suitable "n" value. Retardance factors will be determined using Table 3.

Table 3 - Vegetal Retardance Factors

Stand	Average Length of Vegetation	Degree Retardance	Stand	Average Length of Vegetation	Degree of Retardance
Good	Longer than 24"	A	Fair	Longer than 24"	B
	11" to 24"	B		11" to 24"	C
	6" to 10"	C		6" to 10"	D
	2" to 6"	D		2" to 6"	D
	Less than 2"	E		Less than 2"	E

Parabolic and trapezoidal channel sizes may be selected using charts in the SCS Engineering Field Manual.

Location

Diversion location will be dictated by outlet condition, topography, land use, soil type, and length of slope. Diversions must be located so that water will empty on established disposal areas, a stable watercourse, waterway, or structure.

The spacing of permanent diversions on long slopes for control of erosion and runoff after construction is a matter of some engineering judgement. Use of the Universal Soil Loss Equation may be helpful in determining spacing.

Diversion (D) (Temporary and Permanent) (Cont'd)

Grade

Channel grade for diversions may be uniform or variable. The permissible velocity for the soil type and vegetative cover will determine the maximum grade. The grade should be such as to minimize standing water and wetness problems.

Level diversions with blocked ends may be used when an adequate underground outlet is provided.

Subsurface Drainage

Underground drains should be used along permanent vegetated diversion channels when adequate grade cannot be achieved to prevent ponding water, when hillside seeps or soils with poor internal drainage keep the channel wet, or when base flow is intercepted by the diversion.

Sediment Protection

Any high sediment-producing area above a diversion should be controlled by good land use management or by structural measures to prevent excessive sediment accumulation in the diversion channel. If movement of sediment into the diversion channel cannot be controlled, then one of the of the following measures should be used:

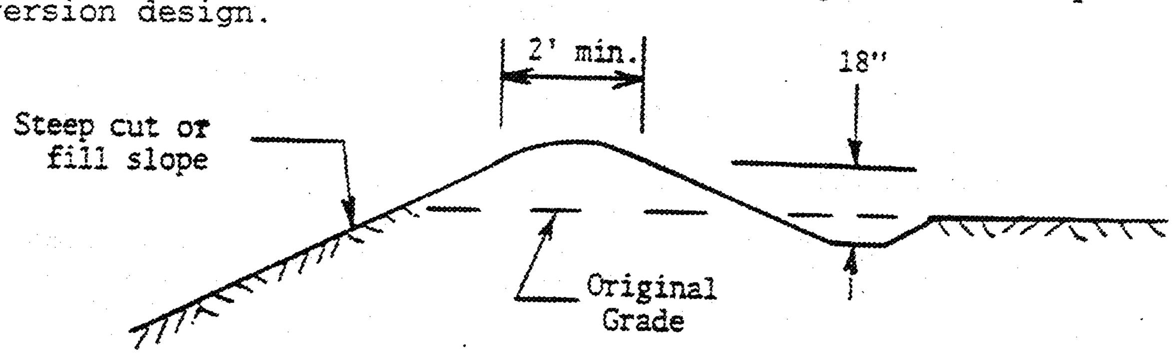
> Design the channel to include extra capacity for the storage of sediment. Keep the velocity of flow for the design storm greater than 1.5 feet per second and provide for clean out of the diversion channel when the sediment storage capacity has been depleted.
>
> Provide a minimum 15-foot wide filter strip of close-growing sod adjacent to the diversion channel. Remove excessive accumulations of sediment to maintain a vigorous growth.

All permanent diversion ridges and channels are to be seeded to grass to prevent erosion.

Diversion (D) (Temporary and Permanent) (Cont'd)

Diversion Dike Above Steep Slopes

Diversion dikes for the temporary protection of cut or fill slopes shall be installed in accordance with the following criteria for drainage areas of five acres or less. Larger areas require a diversion design.



Cross Section

Figure 2

Design Criteria

Top width - 2 ft. minimum
Height (compacted fill) - 18 inches unless otherwise noted on the plans.
(Height measured from the upslope toe to top of the dike).
Side slopes - 2:1 or flatter.
Grade - dependent upon topography, but must have positive drainage to the outlet; may require vegetative or mechanical stabilization where grades are excessive.

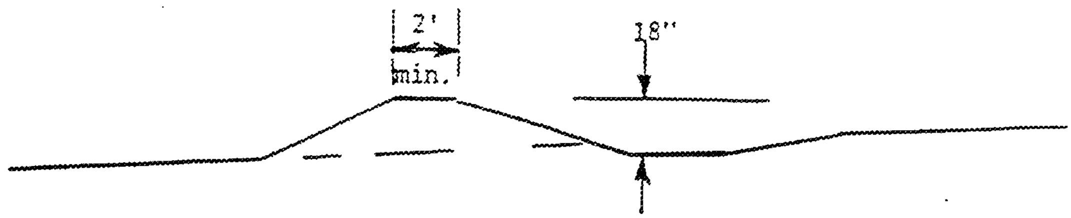
General Notes

1. All diversions must have positive grade draining to a stabilized outlet.
2. Diverted runoff will outlet onto a stabilized undisturbed area, a prepared level spreader, or into a slope protection structure.

Temporary Interceptor Diversion for Graded Right-of-Way

Temporary diversions to intercept runoff on graded rights-of-way shall be installed in accordance with the following criteria for drainage areas of five acres or less. Larger areas require a diversion design.

Diversion (D) (Temporary and Permanent) (Cont'd)



Cross Section

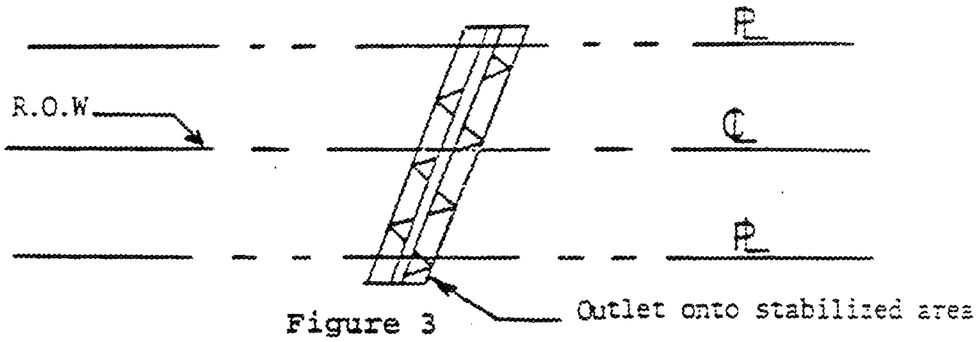


Figure 3

Design Criteria

Top width - 2 ft. min.
Height - 18 inches unless otherwise noted on the plans (measured from the slope toe of the ridge).
Side slopes - 2:1 or flatter (flat enough to allow construction traffic to cross if desired).
Grade - 0.5% to 1.0%
Spacing - 200 to 300 ft. between diversions. (The steeper the slope, the closer the spacing should be.)

General Notes

1. Top width may be wider and side slopes may be flatter, if desired.

2. Field location should be adjusted as needed to provide a stabilized safe outlet.

3. Diverted runoff shall outlet onto an undisturbed stabilized area, a prepared level spreader, or into a slope protection structure.

Diversion (D) (Temporary and Permanent) (Cont'd)

Level Spreader

A level lip spreader shall be used at diversion outlets discharging onto areas already stabilized by vegetation. Spreaders shall be excavated at least 6 inches deep into undisturbed soil. The bottom of the excavation and the downstream lip or edge shall be level. Minimum spreader lengths shall be based on the peak rate of flow from a 10-year frequency storm as indicated in Table 4.

TABLE 4

Designed Q^{10}	Minimum Length
Up to 10	15
11 to 20	
21 to 30	26
31 to 40	36
41 to 50	44

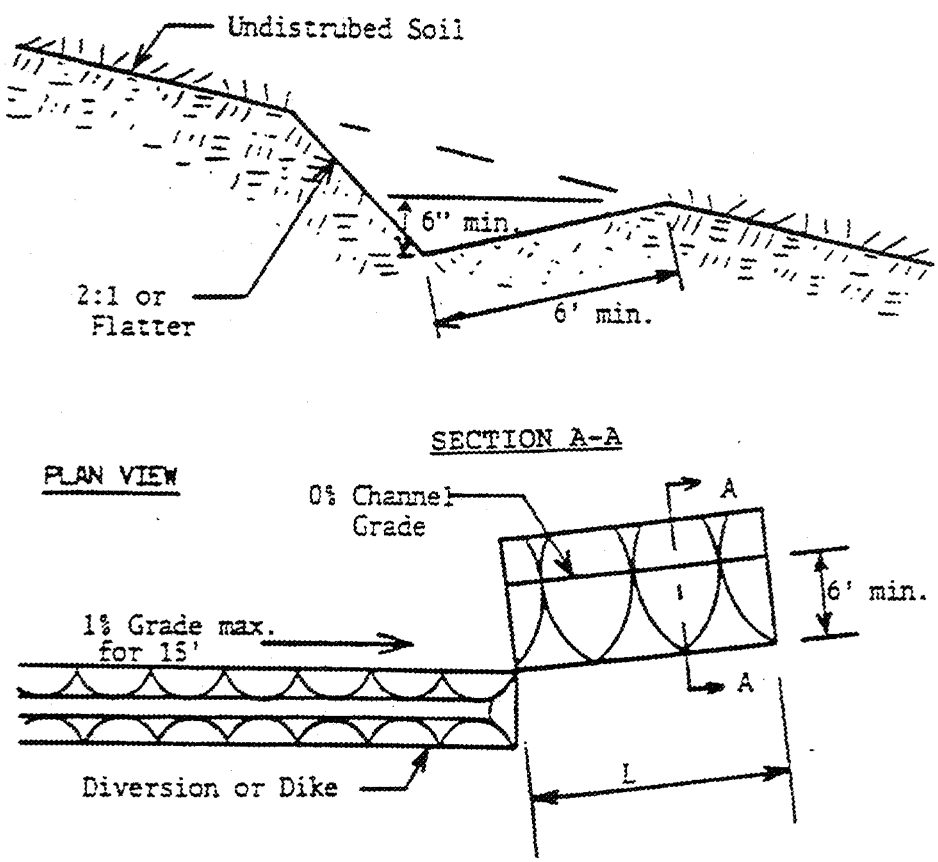


Figure 4

Diversion (D) (Temporary and Permanent) (Cont'd)

General Notes

1. Construct level lip on zero percent grade or ensure uniform spreading of storm runoff (converting channel flow to sheet flow).

2. Level spreaders must be constructed on undisturbed soil (not on fill).

3. Entrance to spreader must be graded in a manner to ensure that runoff enters directly onto the zero percent graded channel.

Operation and Maintenance

The success or failure of a properly designed and constructed diversion depends on the adequacy of the outlet and proper maintenance.

Bare and vegetated diversion channels should be inspected regularly to check for points of scour or bank failure; rubbish or channel obstruction; rodent holes, breaching, or settling of the ridge; excessive wear from pedestrian or construction traffic. Repair damage and remove deposits or sediment from the diversion channel and vegetative filter strip. Reseeding and fertilizing should be done as needed.

Diversion (D) (Temporary and Permanent) (Cont'd)

SPECIFICATIONS

DIVERSION

All dead furrows, ditches or other depressions to be crossed shall be filled before construction begins or as part of construction, and the earthfill used to fill the depressions will be compacted using the treads of the construction equipment. All old terraces, fence rows, or other obstructions that will interfere with the successful operation of the diversion will be removed.

The base for the diversion ridge is to be prepared so that a good bond is obtained between the original ground and the place filled. Vegetation is to be removed and the base thoroughly disked prior to placement of fill.

The earth materials used to construct the earth fill portions of the diversions shall be obtained from the diversion channel or other approved source.

The earthfill materials used to construct diversions shall be compacted by routing the construction equipment over the fill in such a manner that the entire surface of the fill will be traversed by not less than one tread track of the equipment.

When an excess of earth material results from cutting the channel cross section and grade, it shall be deposited adjacent to the supporting ridge unless otherwise directed.

The completed diversion shall conform to the cross section and grade shown on the design.

Fertilizing, seeding, and mulching shall conform to the recommendations in the applicable vegetative standard and specification.

If there is no sediment protection provided on temporary diversion, it should be anticipated that periodic cleanout may be required.

Construction operations shall be carried out in such a manner that erosion and air and water pollution will be minimized. State and local laws concerning pollution abatement shall be complied with.

WATER MANAGEMENT, EROSION AND
SEDIMENT CONTROL FOR CONSTRUCTION AREAS

TECHNICAL STANDARD AND SPECIFICATIONS

Waterway (WV)
(WL)

Definition

A natural or constructed waterway or outlet shaped or graded and established in suitable vegetation as needed for safe disposal of runoff water.

Purpose

To provide for the disposal of excess surface water from construction sites and urban areas without causing erosion.

Condition Where Practice Applies

This practice applies to sites where added capacity or vegetative protection or both are required to control erosion resulting from concentrated runoff.

Supplemental measures may be required with this practice. These may include such things as (1) grade control structures, (2) subsurface drainage to permit growing suitable vegetation and to eliminate wet spots that may be a nuisance, (3) a paved channel bottom or buried storm drain to handle frequency occurring storm runoff, base flow, snowmelt.

Design Criteria

Capacity

Waterway capacity should be adequate to carry the peak rate of runoff from a 10-year frequency storm. Greater capacity may be provided if a higher level of protection is required for commercial or residential buildings. For bare or grass channels with a grade of less than 1 percent, out-of-bank flow may be permitted if such flow will not cause erosion, property or flooding damage. The minimum in such cases should be the capacity to carry a two-year frequency.

Runoff computation will be based upon the most severe soil and cover conditions that will exist in the area draining into the waterway during the planned life of the structure. Runoff will be computed by the method outlined in the SCS Engineering Field Manual, Chapter 2, or by other acceptable methods.

Waterway (WV) (WL) (Cont'd)

Cross Section

The cross section or shape of waterway channels may be triangular, parabolic, or trapezoidal. All waterway cross sections should be designed to permit easy crossing of equipment during construction and maintenance.

The parabolic shape is the preferred cross section. Most waterways constructed with a trapezoidal section tend to revert to parabolic cross section. The triangular cross section concentrates flow in the "V" of the channel causing higher and more erosive velocities. When bare or vegetated triangular channels are used, the minimum side slopes should be 6:1 or flatter.

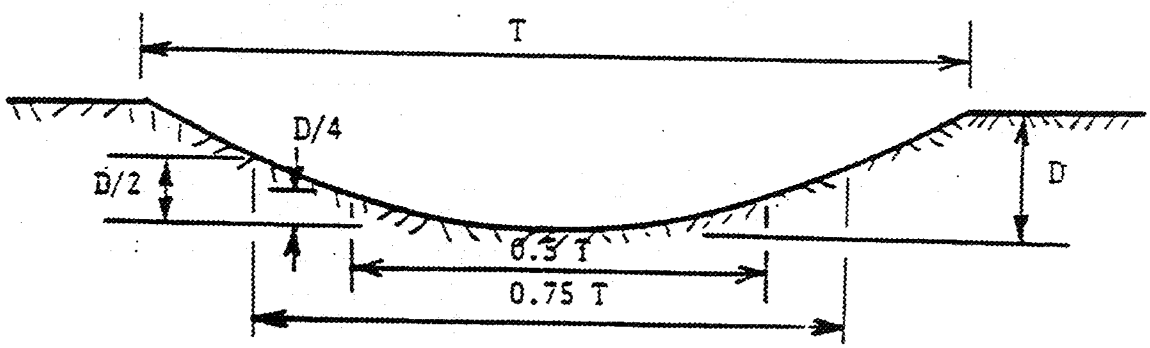


Figure 1

Parabolic Cross Section

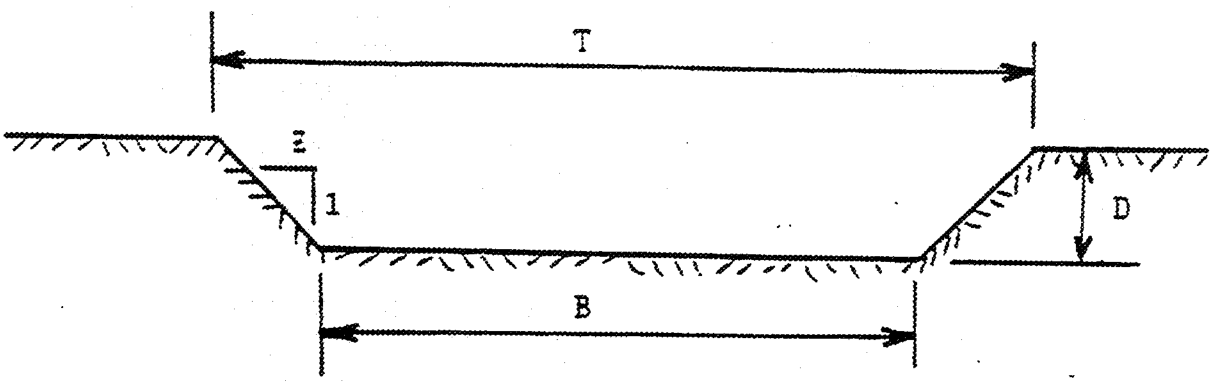


Figure 2

Trapezoidal Cross Section

Waterway (WV) (WL) (Cont'd)

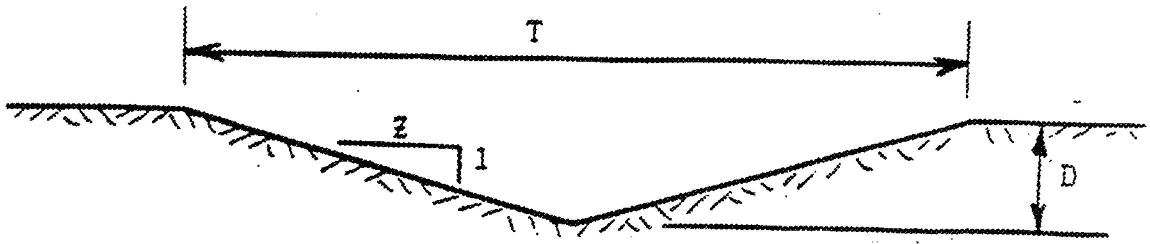


Figure 3

Triangular Cross Section

TYPICAL WATERWAY CROSS SECTIONS

Velocity

The design velocity is to be based upon soil, duration of flow, and quality of vegetation. Design velocities will be determined using Table 1, except that velocities exceeding 5 feet per second shall be used only where good cover and proper maintenance can be attained.

Table 1 - Permissible Velocities

Soil Texture	Allowable Velocity (V) in Ft./Sec			
	Bare Channel	Condition of Vegetation		
		Poor	Fair	Good
Sand, silt, sandy loam, silt loam	1.5	1.5	2.0	3.0
Silty Clay loam, sandy clay loam	2.0	3.0	4.0	5.0
Clay	2.5	3.0	5.0	6.0

Waterway (WV) (WL) (Cont'd)

Channel Dimension

Channel dimensions will be determined using the appropriate retardance factor or by Manning's formula using a suitable "n" value. Retardance factors will be determined using Table 2.

Table 2 - Vegetal Retardance Factors

Stand	Average Length of Vegetation	Degree Retardance	Stand	Average Length of Vegetation	Degree Retardance
	Longer than 24"	A		Longer than 24"	B
	11" to 24"	B		11" to 24"	C
Good	6" to 10"	C	Fair	6" to 10"	D
	2" to 6"	D		2" to 6"	D
	Less than 2"	E		Less than 2"	E

Parabolic and trapezoidal channel sizes may be selected using charts in the SCS Engineering Field Manual.

Grade

When permanently vegetated waterways are used in developments to manage or convey stormwater, the grade of the channel should be such as to minimize standing water and wetness problems.

Depth

The minimum depth of a waterway receiving water from diversions or tributary channels is to be that required to keep the design water surface in the waterway or outlet at or below the design water surface elevation in the diversion or other tributary channel at their junction. To provide for loss in channel capacity due to vegetal matter accumulation, sedimentation, and normal seedbed preparation, the channel depth and width should be increased proportionally to maintain the hydraulic properties of the waterway. In parabolic channels, this may be accomplished by adding 0.3 foot to the depth and 2 feet to the top width of the channel. This is not required on waterways located in natural watercourses.

Where a paved bottom is used in combination with vegetated side slopes, the paved section is to be designed to handle the base flow, snowmelt or runoff from a one-year frequency storm, whichever is greater. The flow depth of the paved section shall be a minimum of 0.5 foot.

Waterway (WV) (WL) (Cont'd)

Subsurface Drainage

Subsurface drainage may be required for bare and vegetated channels in areas with a high water table, seepage problems or prolonged low flows from adjacent property. Underdrains, stone center drains, lined pilot channels, or other suitable subsurface drainage measures may be used. The minimum capacity should be 0.015 cfs/acre of poorly drained soils in the watershed. If local ordinances permit, storm sewers may be used to extend existing agricultural tile or base flow across a development. They may also be used as an underdrain for the waterway if the conduit is opened jointed.

When an underdrain is needed along the waterway channel, it should be located at the edge of the waterway channel. The top of the drain should be at least 2 feet below the bottom of the waterway channel.

Location

The location of waterway channels is of considerable importance to a good program of erosion and sedimentation control. Wherever possible, the planner should preserve the natural drainage system. Waterways should generally be located in natural drainageways where water can drain in from all sides. When the establishment of vegetation is required, moisture conditions and soil fertility are usually best in such areas.

Waterways may also be located along development boundaries, road rights-of-way, back lot lines or along storm sewer center lines. In all situations, waterway channels should be located so that they do not make sharp, unnatural changes in direction of flow. It is better to design lots to conform to natural features of the land than to have unnatural drainageways result from manipulation of land forms.

All waterways channels should have stable outlets with adequate capacity for the designed flow. The outlet may be another vegetated channel, an earth ditch, a structure, or other suitable outlet. In all cases, the outlet must discharge in such a manner as not to cause erosion. Outlets should be constructed and stabilized prior to the operation of the waterway channel. Applicable Kentucky drainage laws, traditional case law precedent and local ordinances and regulations must be observed in locating waterway channels and outlets.

Waterway (WV) (WL) (Cont'd)

Sedimentation Protection

Permanent waterway channels should be protected from sediment produced in its watershed. When sediment is not controlled before it reaches the waterway, one or any combination of the following should be used:

1. Installing a vegetative filter strip on each side of the waterway channel where surface water enters.

2. Increasing the depth and corresponding top width to store trapped sediment. Normally 0.3 to 0.5 foot of depth is added.

3. Providing for cleaning out the channel when its designed cross section deteriorates.

Traffic Crossing

Where bare and vegetated waterway channels are to be crossed by construction equipment, the channel should be protected according to the requirements of the stabilized construction entrance practices as given this chapter. Where paved channels are to be crossed, the lining will be designed to carry the expected load. Culverts or bridges of adequate capacity may also be used.

Waterway Lining

Vegetative linings should be chosen in accordance with guidelines given in the vegetative section of this book. Vegetative measures should be started immediately after construction. Any of the following will help achieve rapid establishment:

1. Establishing vegetative cover by sodding part or all of the waterway channel.

2. Using mulch on all waterway seedings.

3. Irrigating sod or seedings.

Structural channel linings should be selected, designed and installed according to the following criteria:

Freeboard - The minimum freeboard for lined waterways or outlets should be 0.25 feet above design high water in areas where erosion-resistance vegetation cannot be grown adjacent to the paved side slopes. No freeboard is required if vegetation can be grown and maintained.

Waterway (WV) (WL) (Cont'd)

Side Slope - The steepest permissible side slopes horizontal to vertical should be:

Non-reinforced concrete:

Hand-placed, formed concrete
Height of lining, 1.5 ft. or less .....Vertical

Hand-placed screened concrete or mortared in-place flagstone -
Height of lining, 2 ft. or less....1 to 1
Height of lining, more than 2 ft...2 to 1

Slip from concrete:
Height of lining, less than 3 ft........1 to 1
Rock riprap: ....2 to 1

Lining thickness - Minimum lining thickness should be:

Concrete (reinforced) ....4 in. (In most problem areas, minimum thickness should be 5 in. with welded wire fabric reinforcing.

Rock riprap..................1.5 x maximum stone size, plus thickness of filter or bedding.

Flagstone....................4 inches, including mortar bed.

Related structures - Side inlets, drop structures, and energy dissipators should meet the hydraulic and structural requirements for both the site and off-site discharge conditions.

Filter or bedding - Filters or bedding should be used to prevent piping. Drains should be used to reduce uplift pressure and to collect water, as required. Weep holes may be used with drains if needed.

Concrete - Concrete used for lining should be proportioned so that it is plastic enough for thorough consolidation and stiff enough to stay in place on side slopes. A dense, durable product should be required. Specify an air-entrained mix that can be certified as suitable to produce a minimum strength of at least 3,000 psi. Cement used should be Portland cement, Types I, II, or if required, Types IV or V. Aggregate used should have maximum size of 1-1/2 in.

Waterway (WV) (WL) (Cont'd)

Mortar - Mortar used for mortared-in-place flagstone should consist of a workable mix cement, sand, and water with a water-cement ration of not more than six gallons of water per bag of cement.

Contraction joints - Contraction joints in concrete linings, if required, should be formed transversely to a depth of about one-third the thickness of the lining at a uniform spacing in the range of 10 to 15 feet. Provide for uniform support of the joint to prevent unequal settlement.

Rock riprap or flagstone - Stone used for riprap should be dense and hard enough to withstand exposure to air, water freezing, and thawing. Flagstone should be flat for ease of placement and have the strength to resist exposure and breaking.

Cutoffs - Cutoff walls should be used at the beginning and ending of concrete linings. Other channel linings should be keyed into the channel at both ends of the lining.

SPECIFICATIONS

WATERWAY

All trees, brush, stumps, and other objectionable material shall be removed and disposed of in a manner so that they will not interfere with construction or the proper functioning of the waterway or outlet.

The waterway or outlet shall be constructed to the dimensions specified on the design, and the cross section shall be free from bank projections or other irregularities.

All ditches or other depressions below the designed grade will be back filled with fill material that is free from brush, roots, sod or other perishable material, and rocks in excess of 6 inches in diameter. Backfill will be placed in approximately uniform horizontal layers of not more than 9 inches in thickness and each layer will be compacted using the treads or tracks of the construction equipment.

All excavated material not needed in the construction of the waterway or outlet shall be spread or disposed of so it will not interfere with the flow of water into the waterway.

Waterway (WV) (WL) (Cont'd)

When specified on the design, topsoil from the construction area will be preserved by stockpiling. After the waterway has been constructed to proper grades and cross section with proper allowance for topsoil, the topsoil will be uniformly spread over the area to a minimum depth of four (4) inches.

Waterways or outlets shall be protected against erosion by vegetative means as soon after construction as practical and before diversions or other channels are released into them. Consideration should be given to sodding channels to provide erosion protection immediately after construction.

Seeding, fertilizing, mulching, and sodding shall be performed according to Critical Area Planting Specifications.

Check Dam (CD)

Definition

Small, temporary dams constructed across a swale or drainage ditch. A swale is a low-lying or depressed stretch of land.

Purpose

To reduce the velocity of concentrated stormwater flows, thereby reducing erosion of the swale or ditch. This practice also traps small amounts of sediment generated in the ditch itself. However, this is not a sediment-trapping practice and should not be used as such.

Conditions Where Practice Applies

This practice is limited to use in small, open channels that drain 10 acres or less. It should not be used in live streams. They are especially applicable to sloping sides where the gradient of waterways is close to the maximum for a grass lining. Some specific applications include:

1. Temporary ditches or swales which, because of their short length of service do not receive a non-erodible lining but still need some protection, reduce erosion.

2. Permanent ditches or swales, which for some reason cannot receive a permanent non-erodible lining for an extended period of time.

Planning Considerations

Check dams can be constructed of either stones or logs. Log check dams are more economical from the standpoint of material costs, since logs can usually be salvaged from clearing operations. However, log check dams require more time and hand labor to install. Stone for check dams, on the other hand, must generally be purchased. However, this cost is offset somewhat by the ease of installation.

If stone check dams are used in grass-lined channels that will be mowed, care should be taken to remove all stone from the dam when the dam is removed. This should include any stone that has washed downstream.

Check Dam (CD) (Cont'd)

Since log check dams are embedded in the soil, their removal will result in more disturbance of the soil than will removal of stone check dams. Consequently, extra care should be taken to stabilize the area when log dams are used in permanent ditches or swales.

SPECIFICATIONS

No formal design is required for check dam; however, the following criteria should be adhered to when specifying dams.

The drainage area of the ditch or swale being protected should not exceed 10 acres. The maximum height of the check dam should be 2 feet. The center of the check dam must be at least 6 inches lower than the outer edges.

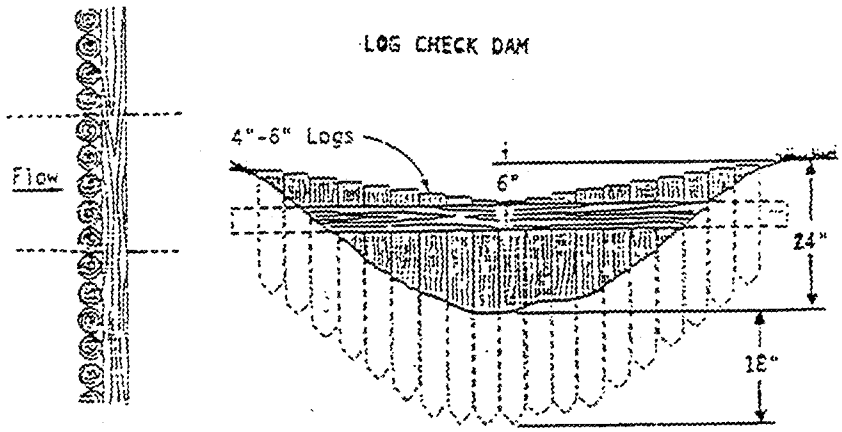


Figure 1

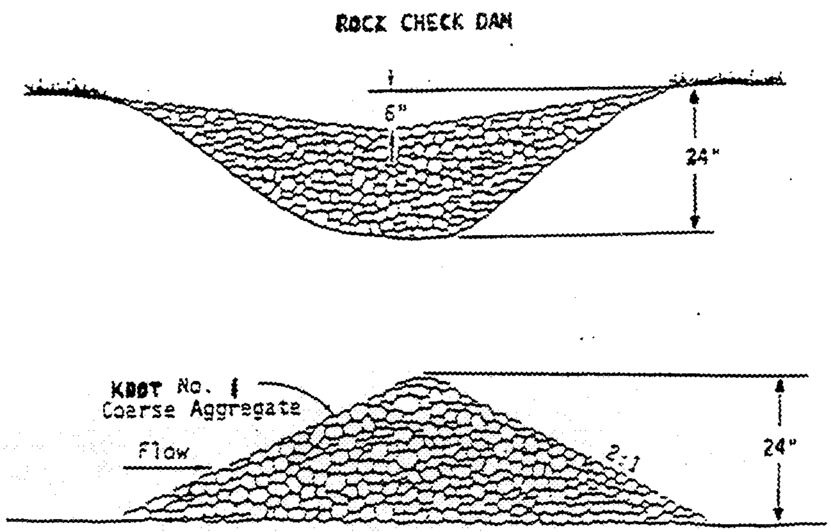
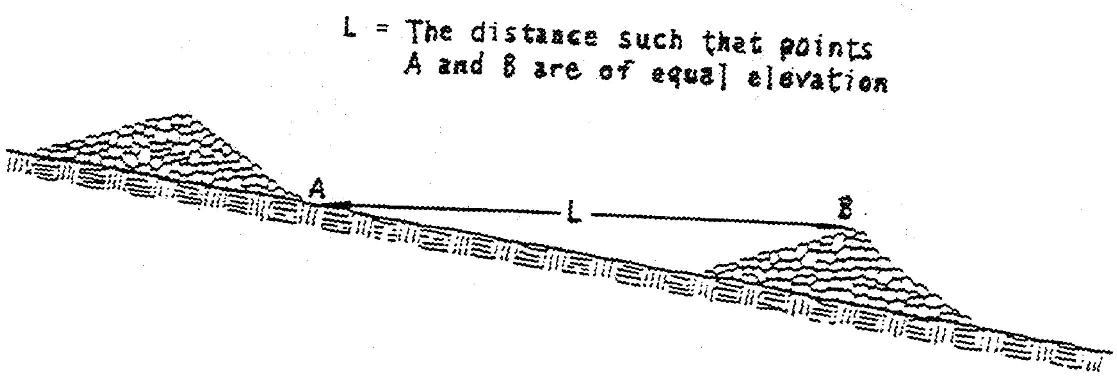


Figure 2

Check Dam (CD) (Cont'd)

The maximum spacing between the dams should be such that the toe of the upstream dam is at the same elevation as the top of the downstream dam.



SPACING BETWEEN CHECK DAMS

Figure 3

Stone check dams should be constructed of KDOT Aggregate No. 2 (1.5 to 3-inch stone). The stone should be placed according to the configuration shown above. Hand or mechanical placement will be necessary to achieve complete coverage of the ditch or swale and to ensure that the center of the dam is lower than the edges.

Check Dam (CD) (Cont'd)

Log check dams should be constructed of 4- to 6-inch logs salvaged from clearing operation site, if possible. The logs should be embedded into the soil at least 18 inches. The 6-inch lower height required at the center can be achieved either by careful placement of the logs or by cutting the logs after they are in place. Logs and/or brush should be placed on the downstream side of the dam to prevent scour during high flows.

Sediment Removal

While this practice is not intended to be used primarily for sediment trapping, some sediment will accumulate behind the check dams. Sediment should be removed from behind the check dams when it has accumulated to one-half of the original height of the dam.

Removal

Check dams must be removed when their useful life has been completed. In temporary ditches and swales, check dams should be removed and the ditch filled in when it is no longer needed. In permanent structures, check dams should be removed when a permanent lining can be installed. In the case of grass-lined ditches, check dams should be removed when the grass has matured sufficiently to protect the ditch or swale. The area beneath the check dams should be seeded and mulched or sodded (depending upon velocity) immediately after they are removed.

Maintenance

Check dams should be checked for sediment accumulation after each significant rainfall. Sediment should be removed when it reaches one-half of the original height or before.

Regular inspections should be made to ensure that the center of the dam is lower than the edges. Erosion caused by high flows around the edges of the dam should be corrected immediately.

WATER MANAGEMENT, EROSION AND
SEDIMENT CONTROL FOR CONSTRUCTION AREAS

TECHNICAL STANDARD AND SPECIFICATIONS

Subsurface Drainage (SD)

Definition

A perforated conduit such as pipe, tubing or tile installed beneath the ground to intercept and convey groundwater.

Purpose

1. To prevent sloping soils from becoming excessively wet and subject to sloughing.

2. To improve the quality of the growth medium in excessively wet areas (such as in diversions or waterways) by lowering the water table.

3. To drain stormwater detention areas or structures.

Conditions Where Practice Applies

Wherever excess water must be removed from the soil. The soil must be deep and permeable enough to allow an effective system to be installed. Either a gravity outlet must be available or pumping must be provided. These standards do not apply to foundation drains.

Planning Considerations

Subsurface drainage systems are of two types, relief drains and interceptor drains. Relief drains are used either to lower the water table in order to improve the growth of vegetation or to remove surface water. They are installed along a slope and drain in the direction of the slope. They can be installed in a gridiron pattern, a herringbone pattern, or a random pattern (see Figure 1.)

Interceptor drains are used to remove water as it seeps down a slope to prevent the soil from becoming saturated and subject to slippage. They are installed across a slope and drain to the side of the slope. They usually consist of a single pipe or series of single pipes instead of a patterned layout (see Figure 2).

Subsurface Drainage (SD) (Cont'd)

DESIGN CRITERIA

Location

Tree roots can often clog subsurface drain systems. Consequently, subsurface drains should be located such that there are no trees within 50 feet of the drain or use continuous non-perforated pipe.

Relief drains - Relief drains should be located through the center of wet areas. They should be installed across the slope and drain to the side of the slope.

Interceptor drains - Interceptor drains should be located on the uphill side of wet areas. They should be installed across the slope and drain to the side of the slope.

Capacity of drains - The required capacity of a subsurface drain depends upon its use.

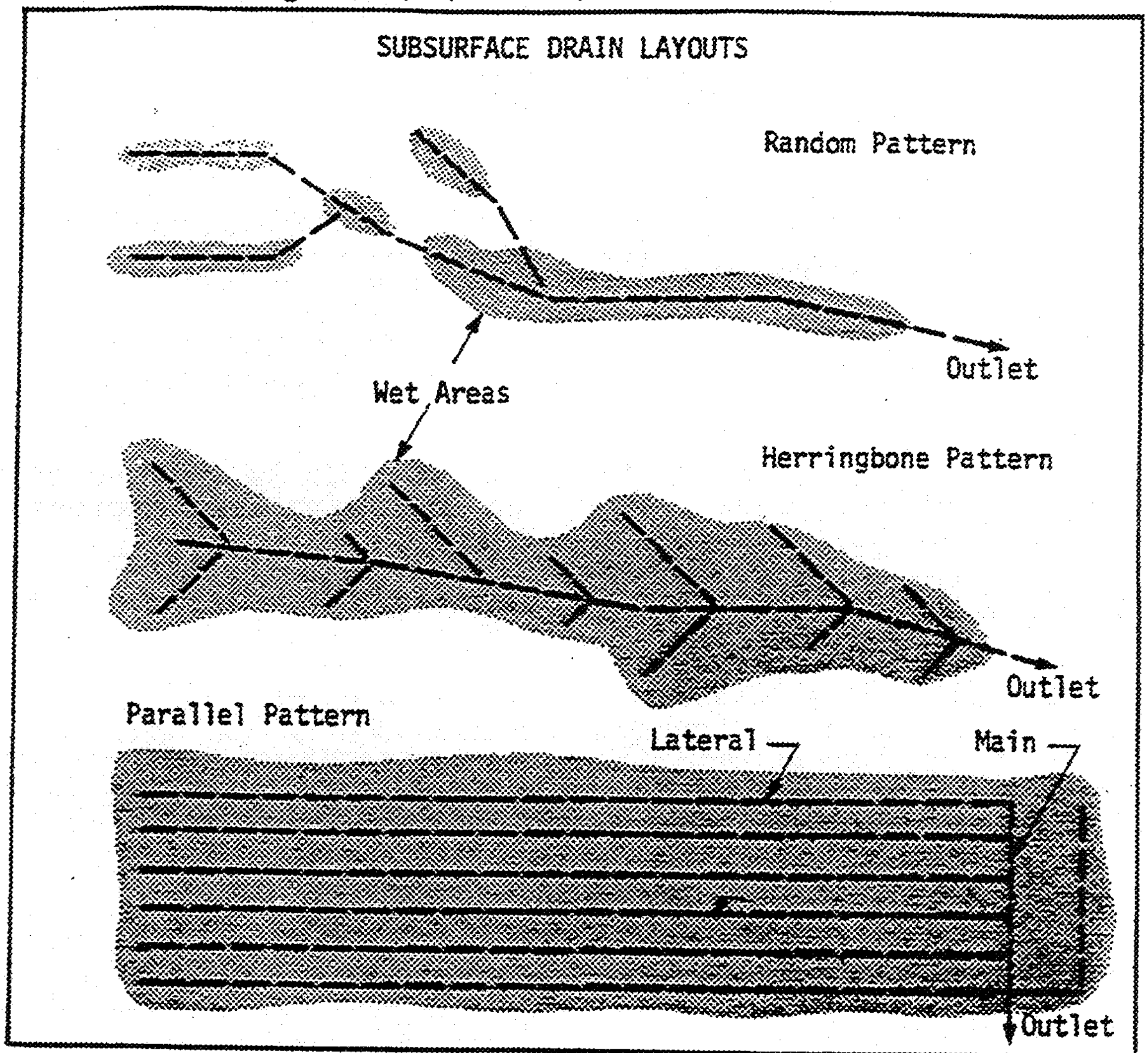
Relief drains - Relief drains installed in a uniform pattern should remove a minimum of 1 inch of groundwater in 24 hours (0.042 cfs/acre). The design capacity must be increased accordingly to accommodate any surface water that enters directly into the system (Footnote 1 and example in Figure 3).

Table 1
INTERCEPTOR DRAIN INFLOW RATES

Soil Texture	Inflow Rate Per 1000 Feet of Line in CFS [1] Land Slope%			
	0-2	-5	-12	Over 12
Coarse sand gravel	1.00	1.10	1.20	1.30
Sand	0.50	0.55	0.60	0.65
Sandy loam	0.25	0.28	0.30	0.33
Silt loam	0.10	0.11	0.12	0.13
Clay and clay loam	0.20	0.22	0.24	0.26

[1] Discharge of flowing springs or direct entry of surface flow through a surface inlet or filter must be added to the values in the chart. Such flow should be measured or estimated.

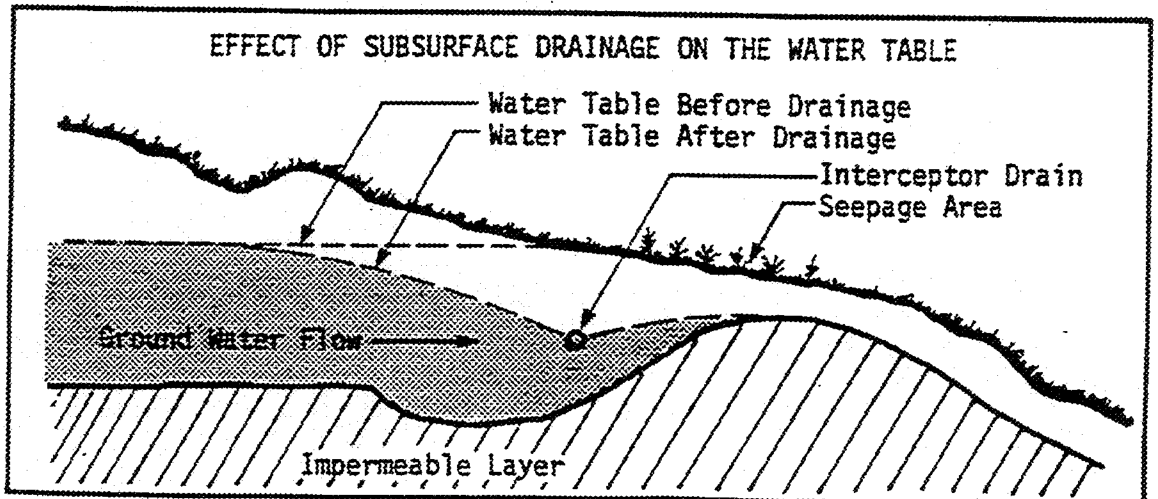
Subsurface Drainage (SD) (Cont'd)



Source: USDA-SCS

Figure 1

Plate 1.50a



Source: USDA-SCS

Figure 2

Subsurface Drainage (SD) (Cont'd)

Size of Drain

The size of the drain may be determined by using Figures 4, 5, or 6, or the size may be computed by applying Manning's formula based on one of the following assumptions.

1. Hydraulic grade line parallel to the bottom grade of the drain with the drain following full at design flow.

2. The drain flowing part full where a steep grade or other condition requires excess capacity.

3. Drain flowing under pressure with hydraulic grade line set by site conditions on a grade which differs from that of the drain. This procedure shall be used only where surface water inlets or nearness of the drain to outlets with fixed water elevations permit satisfactory estimates of hydraulic pressure and flow under design conditions.

The minimum size shall be 3 inches.

Depth and Spacing

Relief drains - Relief drains installed in a uniform pattern should have equal spacing between drains, and the drains should be at the same depth. Maximum depth is limited by the allowable load on the pipe, depth to impermeable layers in the soil, and outlet requirements. The minimum depth is 24 inches under normal conditions. Spacing between drains is dependent on soil permeability and the depth of the drain. In general, however, a depth of 3 feet and a spacing of 50 feet will be adequate. For more specific information, see the Kentucky Drainage Guide.

Interceptor drain - The depth of installation of an interceptor drain is influenced mainly by the depth to that the water table is lowered. The maximum depth is limited by the allowable load on the pipe and the depth to an impermeable layer. Minimum depth should be the same as for relief drains.

One interceptor drain is usually sufficient. However, if multiple drains are to be used, determining the required spacing can be difficult. The best approach is to install the first drain--then if seepage or high water table problems occur downslope, install an additional drain or suitable distance downslope.

Subsurface Drainage (SD) (Cont'd)

Velocity and Grade

The minimum velocity required to prevent silting is 1.4 ft./sec. The line should be graded to achieve at least this velocity. Steep grades should be avoided, however. Table 2 below lists maximum velocities for various soil textures.

Table 2
MAXIMUM VELOCITIES FOR VARIOUS SOIL TEXTURES

Soil Texture	Maximum Velocity - ft./sec.
Sandy and Sandy Loam	3.5
Silt and Silt Loam	5.0
Silty Clay Loam	6.0
Clay and Clay Loam	7.0
Coarse Sand and Gravel	9.0

Filters and Filter Material

Suitable filters shall be used around conduits if they are needed because of site conditions, to prevent sediment accumulation in the conduit. The need for a filter shall be determined by the characteristics of the soil materials at drain depth and the velocity of flow in the conduit. Characteristics of the backfill material in the lower 12 inches of the trench may require the use of filters.

Not less than 3 inches of filter material shall be used for sand-gravel filters. The filter shall be designed to prevent the material in that the installation is made from entering the conduit. Not more than 10 percent of the filter material shall pass the No. 60 sieve.

Artificial fabric or mat-type materials may be used, provided that the effective opening size, strength, durability, and permeability are adequate to consistently filter the soil to protect subsurface drain operations throughout the expected life of the system. (These filters should not be used under submerged conditions or where sediment-laden flows occur prior to backfill.)

Envelopes and Envelope Material

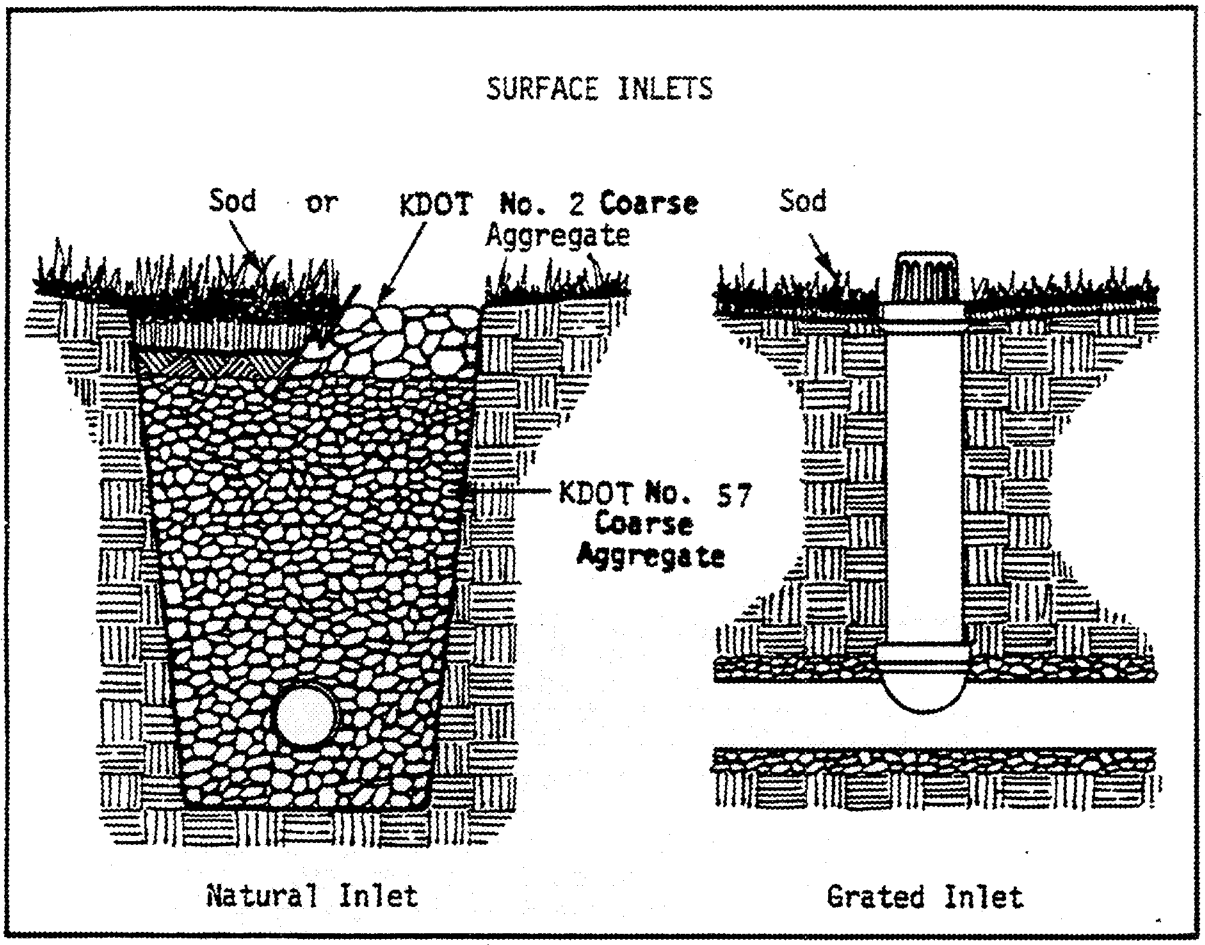
Envelopes shall be used around subsurface drains where required for proper bedding of the conduit or where necessary to improve the characteristics of flow of groundwater into the conduit.

Subsurface Drainage (SD) (Cont'd)

Materials used for envelopes do not need to meet the gradation requirements of filters, but they shall not contain materials that will cause an accumulation of sediment in the conduit or render the envelope unsuitable for bedding of the conduit. Envelope materials shall consist of sand-gravel mixtures, all of that shall pass a 1-1/2 inch sieve, 90 percent to 100 percent shall pass a 3/4 inch sieve, and not more than 10 percent shall pass a No. 60 sieve.

Surface Water

Figure 3 shows two types of surface water inlets. The grated inlet should not be used where sediment might be a problem.



Source: USDA-SCS

Figure 3

Subsurface Drainage (SD) (Cont'd)

Outlet

The outlet of the subsurface drain shall empty into a channel or some other watercourse that will remove the water from the outlet. It shall be above the mean water level in the receiving channel. It shall be protected from erosion, undermining, damage from periods of submergence, and the entry of small animals into the drain.

The outlet shall consist of a 10-foot section of corrugated metal, cast iron, or steel pipe without perforations. No envelope material shall be used around the pipe. At least two-thirds of the outlet pipe length shall be buried.

Materials

Acceptable materials for subsurface drains include perforated continuous closed-joint conduits or corrugated plastic, concrete, corrugated metal, and clay. The strength and durability of the pipe shall meet the requirements of the site in accordance with the manufacturer's specifications.

Placement and Bedding

All subsurface drains, whether flexible conduit such as plastic or rigid conduit such as clay and concrete, shall be laid to a near line and grade. Conduits shall be placed and bedded as described in ASTM-F-449, "Standard Recommended Practice for Subsurface Installation of Corrugated Thermoplastic Tubing for Agricultural Drainage or Water Table Control," except that:

1. Rigid drainage conduits, such as clay or concrete drain tile, do not need the 90 degree V-groove in the trench bottom However, the trench bottom must be shaped so that good alignment in the center of the trench is assured.

2. The V-groove shall not be used for flexible conduits exceeding 8 inches in diameter, because the void under the conduit will create a potential path for soil erosion. A semicircular or trapezoidal groove shaped to fit the conduit shall be used for flexible conduits exceeding 8 inches in diameter.

Subsurface Drainage (SD) (Cont'd)

Use of Heavy-Duty Corrugated Plastic Drainage Tubing

Heavy-duty corrugated drainage tubing shall be specified where rocky or gravelly soils are expected to be encountered during installation operations. The quality of tubing will also be specified when cover over this tubing is expected to exceed 24 inches for 4-, 5-, 6-, or 8-inch tubing. Larger size tubing designs will be handled on an individual job basis.

Auxiliary Structure and Subsurface Drain Protection

The outlet shall be protected against erosion and undermining of the conduit, against damaging periods of submergence and against entry of rodents or other animals into the subsurface drain. An animal guard shall be installed on the outlet end of the pipe.

A continuous 10-foot section of corrugated metal, cast iron, or steel pipe without perforations shall be used at the outlet end of the line and shall outlet 1.0 foot above the normal elevation of low flow in the outlet ditch or above mean high tide in tidal areas. No envelope material shall be used around the 10-foot section of pipe. Two-thirds of the pipe shall be buried in the ditch bank, and the cantilevered section shall extend to a point above the toe of the ditch side slope. If not possible, the side slope shall be protected from erosion.

Conduits under roadways and embankments shall be watertight and designed to withstand the expected loads.

Where surface water is to be admitted to subsurface drains, inlets shall be designed to exclude debris and prevent sediment from entering the conduit. Lines flowing under pressure shall be designed to withstand the resulting pressures and velocity of flow. Surface waterways shall be used where feasible.

The upper end of each subsurface drain line shall be stabilized with gravel or other durable material unless connected to a structure.

SPECIFICATIONS

1. The trench shall be constructed on a continuous grade with no reverse grades or low spots.

2. Soft or yielding soils under the drain shall be stabilized with gravel or other suitable material.

Subsurface Drainage (SD) (Cont'd)

3. Deformed, warped, or otherwise unsuitable pipe shall not be used.

4. Envelopes or filter material shall be placed as specified with at least 3 inches of material on all sides of the pipe.

5. Backfilling shall be done immediately after placement of the pipe. No sections of pipe should remain uncovered overnight or during a rainstorm. Backfill material shall be placed in the trench in such a manner that the drain pipe is not displaced or damaged.

<u>Maintenance</u>

1. Subsurface drains should be checked periodically to ensure that they are free-flowing and not clogged with sediment.

2. The outlet should be kept clean and free of debris.

3. Surface inlets should be kept open and free of sediment and other debris.

4. Trees located too close to a subsurface drain often clog the system with their roots. If a drain becomes clogged, relocate the drain, remove the trees, or replace with continuous non-perforated pipe.

5. Where drains are crossed by heavy vehicles, the line should be checked to ensure that it is not crushed.

Subsurface Drainage (SD) (Cont'd)

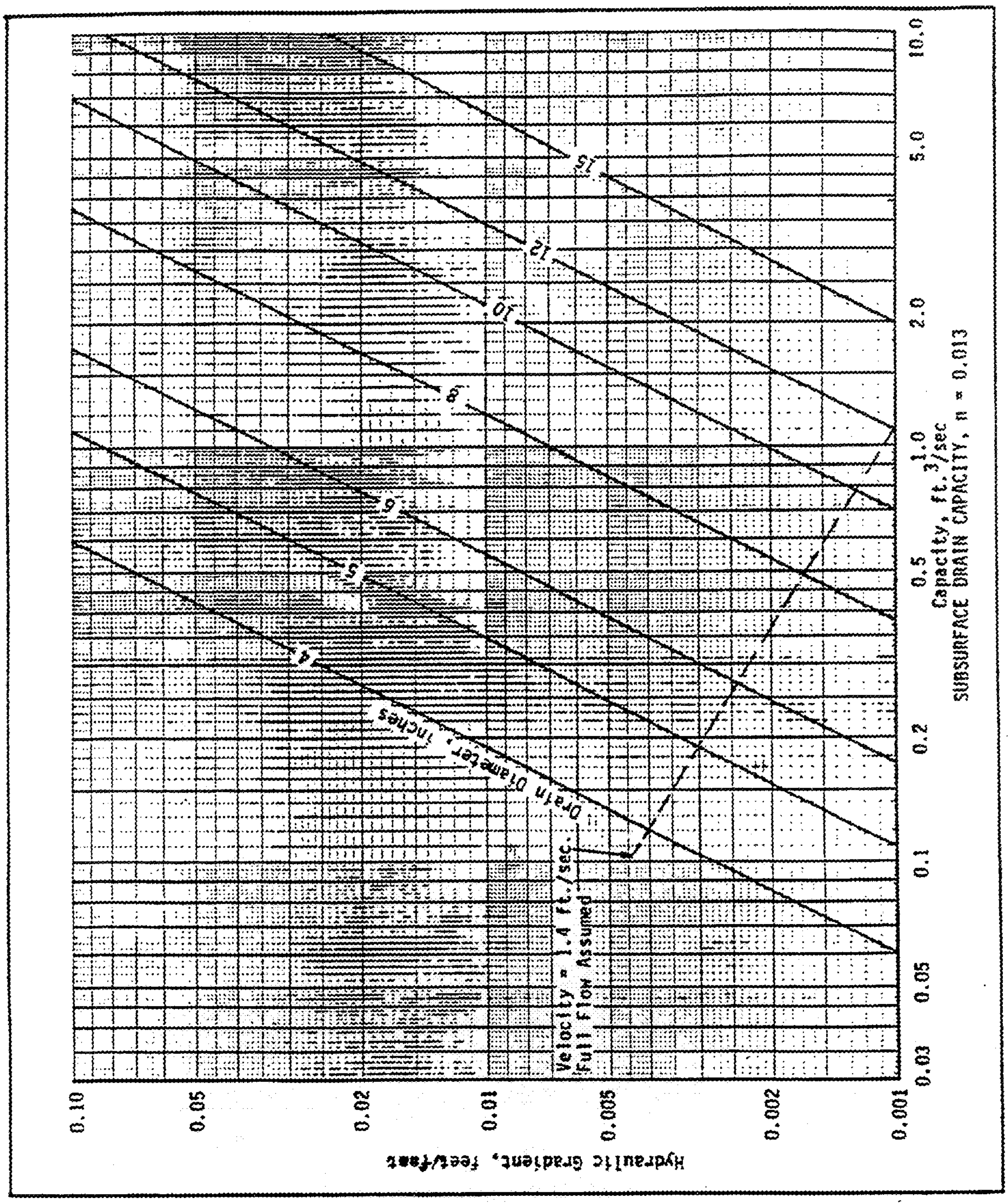
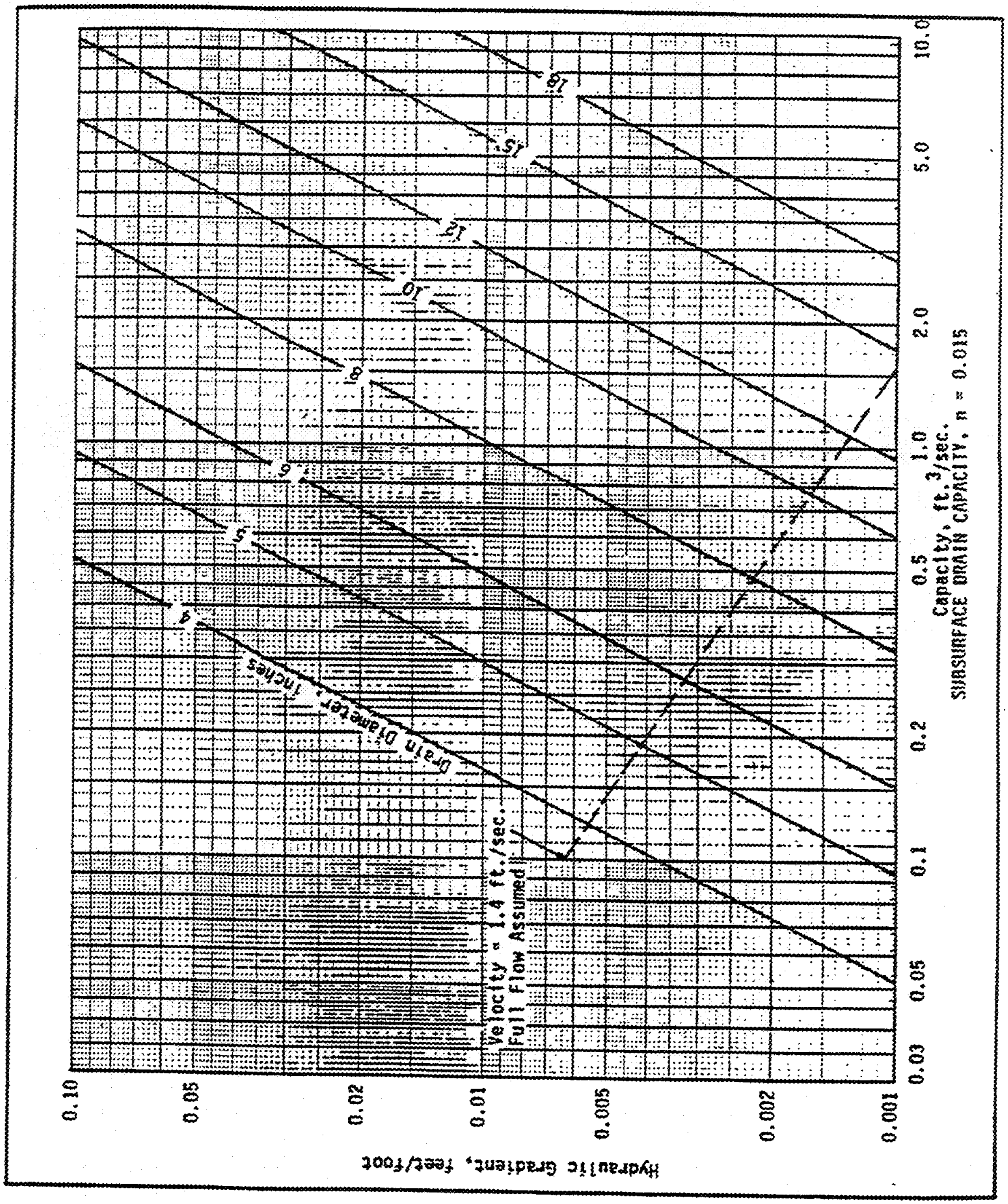


Figure 4
For clay, concrete and bituminized pipe.
(Chart based on excellent tile alignment)

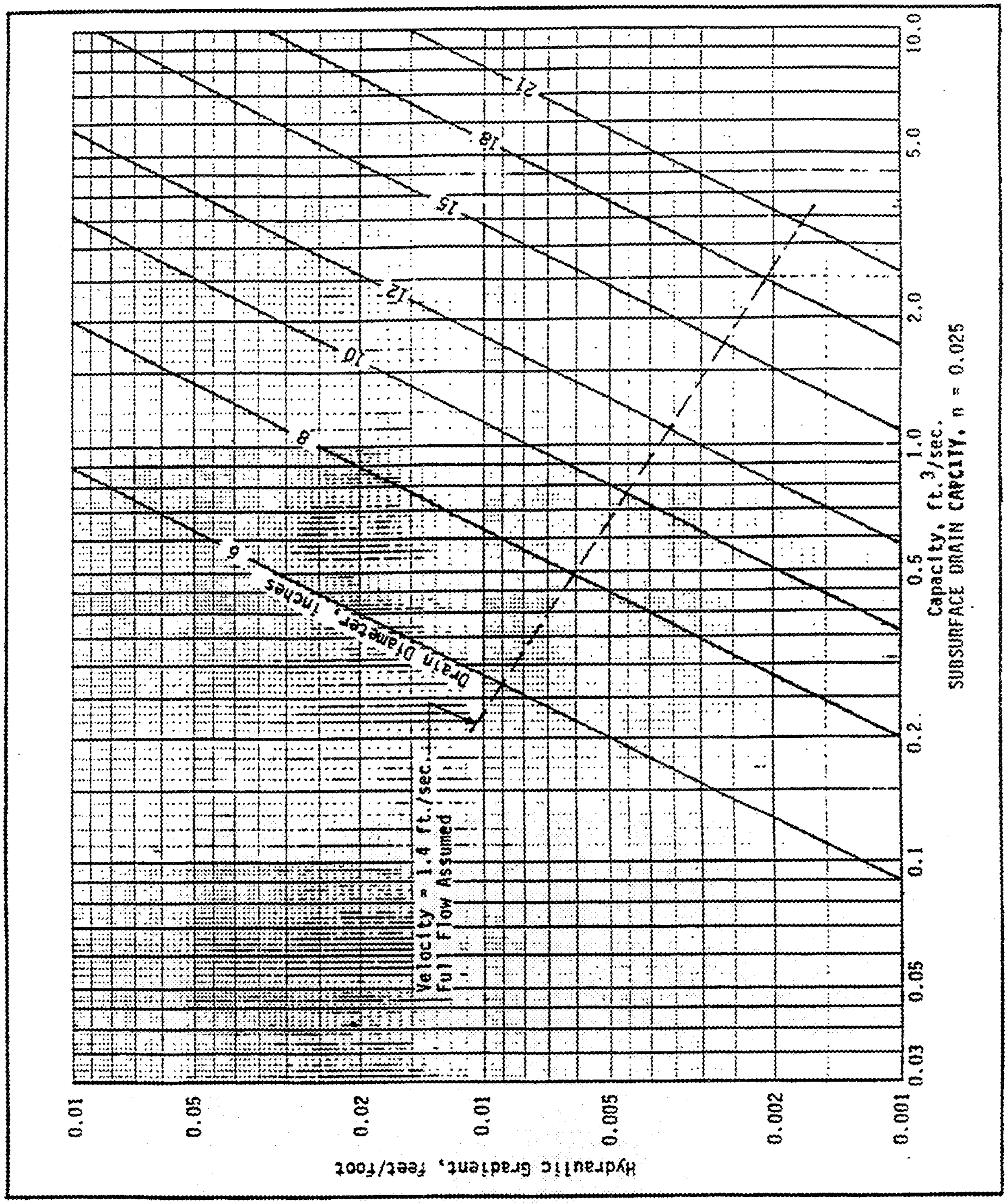
Subsurface Drainage (SD) (Cont'd)



Source: USDA-SCS

Figure 5
For corrugated plastic drain tubing.

Subsurface Drainage (Cont'd)



Source: USDA-SCS

Plate 1.50g

Figure 6

WATER MANAGEMENT, EROSION AND
SEDIMENT CONTROL FOR CONSTRUCTION AREAS

TECHNICAL STANDARD AND SPECIFICATIONS

Stormwater Retention Basins (SRB)

Definition

A basin or depressional area to temporarily retain stormwater on site providing for infiltration, pollution reduction, and downstream water quality improvement.

Purpose

To incorporate pollution control and groundwater recharge concepts into the design and construction of storage areas for the percolation of stormwater runoff so that the adverse impact of urban type development on receiving waters can be reduced.

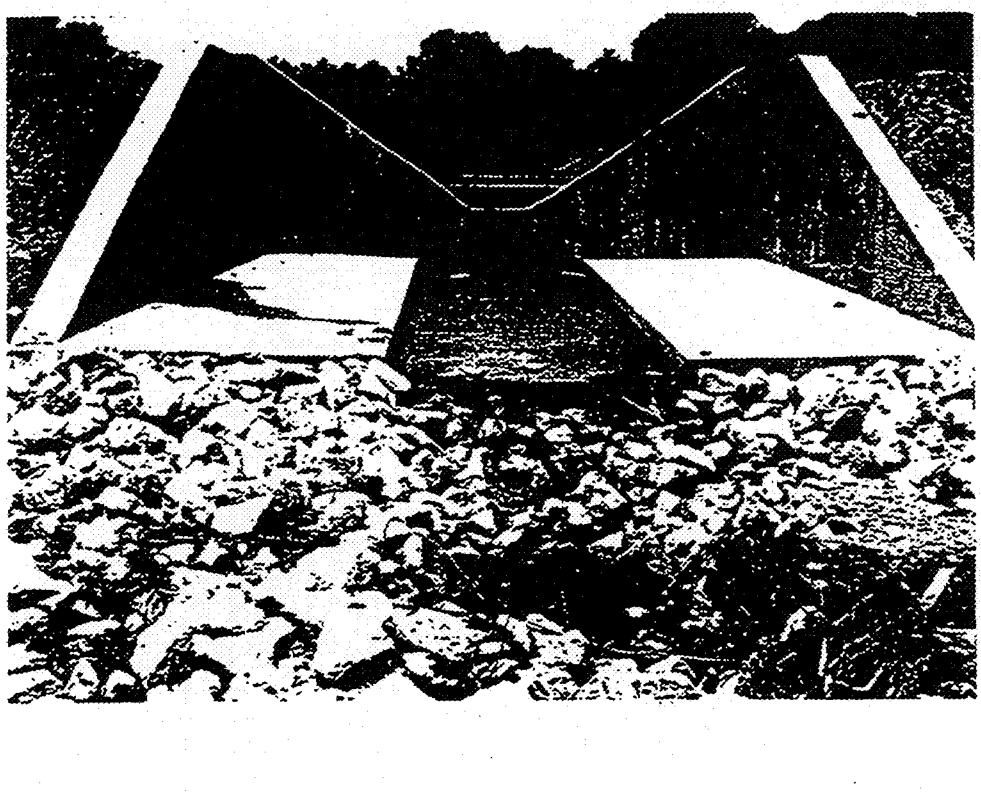


Figure 1
Typical stormwater retention basin installation.

Stormwater Retention Basins (SRB) (Cont'd)

Conditions Where Practice Applies

Applicability of this practice is primarily dependent upon the availability on an adequate site for a retention area or for the creation or modifications of a retention area. Geologic, topographic, and soils conditions must be considered in determining site suitability. The most significant limiting factor in many cases is the availability of sufficient land area to provide the necessary storage volume. This is particularly true in densely urbanized areas where land is scarce and property values are high.

The soil and water table conditions must also be such that the system can, within a maximum of 72 hours following a stormwater event, provide for a new volume of storage through percolation. Retention systems do not release stored waters for surface discharge. Stormwater in excess of storage capacity will be allowed to bypass the retention basin.

Planning Considerations

Retention basins are often designed and constructed for a number of purposes other than nonpoint source pollution control. The purpose may be groundwater recharge, flood protection, aesthetic improvement or any combination. All elements of any impounding structure must be designed, modified, and/or constructed and operated in conformance with good engineering practice.

Basins are generally open excavated depressions of varying size for storage and infiltration of surface water. They can be located in available land areas within a road right-of-way, within open land areas of developments, within recreational sites such as playgrounds or athletic fields, and within natural or landscaped depressions. Their principal drawback is that they require considerable space. However, where space is available, they may be the least expensive recharge system to construct per unit of water handled.

Retention systems are suitable over much of Kentucky, but they are particularly desirable in areas with deep loamy soils. Pollutants in stormwater, including suspended solids, oxygen-demanding materials, heavy metals, bacteria, some varieties of pesticides, and nutrients such as phosphorus are removed as runoff percolates through the vegetation and soil profile.

Stormwater Retention Basins (SRB) (Cont'd)

As stormwater percolates through the soil into underlying geologic formations, the form and concentration of pollutants will be subject to alteration by a variety of physical, chemical and biological processes. Unless these interactions are well understood and considered in the design of infiltration and seepage facilities, the possibility of groundwater contamination and/or surface water degradation through lateral transmission is always a threat.

The following recommendations should be followed when planning and designing a retention system:

1. Lateral distances between seepage structures and surface waters should be maintained as large as possible (e.g., at least 100 ft. or more) depending upon site conditions.

2. Treatment practices should take greater advantage of the unsaturated zone for reduction of pollutants. Where feasible, grassed waterways are preferable to curb and gutter systems.

3. Control stormwater runoff and its associated pollutants at their source whenever possible. A number of small retention facilities would be preferable to a single large facility.

4. When possible, the bottom of retention facilities should be at least 3 feet above the mean high water table elevation. This will ensure sufficient soil for vegetation to promote pollutant removal.

5. Seepage systems should not be located in close proximity to drinking water supply wells. Stormwater treatment facilities should be at least 100 feet from any public water supply well.

6. Industrial and commercial land uses may have unusual contaminants in the stormwater runoff. Stormwater discharges that include synthetic organic compounds such as solvents (e.g., from marine maintenance areas, airport, etc.) should be monitored for several storms before final stormwater management plans are made. The presence or absence of pollutants that might not be treatable via filtration through the soil or sand should be established and treatment provided for in the designed system.

Stormwater Retention Basins (SRB) (Cont'd)

7. The basin depth should be as shallow as possible with a flat bottom (no deep spots). The maximum depth recommended is 2 feet. These retention areas should be incorporated into a project's open space/landscaping.

8. The side slopes and bottoms of all retention basins should be fully vegetated. Vegetation plays a critical role in the removal of contaminants from stormwater and stabilization of side slopes.

9. Pretreatment for stormwater prior to entering the retention basin should be designed into the system whenever possible. Pretreatment of stormwater by using sheet flow, grassed waterways, off-line landscape infiltration areas, or other measures can remove a large percentage of the pollutants (up to 90 percent) that are contained in stormwater.

10. Projects in areas zoned for industrial land uses shall assure that industrial pollutants do not enter stormwater systems or come in contact with groundwater. Developments permitted in areas zoned for industrial land use should receive more detailed review to assure that they comply with these requirements.

Design Criteria

1. General. All facilities that temporarily impound runoff waters shall be designed to be stable during construction and operation. The facility shall have an overflow bypass for stormwater in excess of storage volume.

2. Calculating Retention Volume. Retention facilities must have the capacity to store and percolate the runoff from the first one-half inch or runoff within 72 hours. However, some local review agencies may require greater retention levels. The use of a retention facility is usually associated with some sort of collection system with storage volume regulated by an overflow or bypass spillway. Since retention depends primarily on soil percolation rates, the soils in the vicinity of the pond must be tested to determine infiltration rates and to locate the water table depth.

Stormwater Retention Basins (SRB) (Cont'd)

Assuming that a retention basin will percolate stormwater before the next storm event, a volume of storage can be calculated using the following formula:

$$Vm = \frac{A \times DI}{12} \quad \text{where:}$$

Vm = minimum basin volume (acre-feet)
A = contributing watershed area (acre) (maximum 10 acres)
DI = diversion volume (.5 inches minimum)
12 = conversion factor (in/ft)

3. Estimating and Evaluating Drawdown Time Requirements. Retention facilities must be capable of providing a new volume of storage within 72 hours following a storm. Facilities designed for recreation or open space, etc., should consider a shorter storage period.

For systems in that the water table elevation is below the bottom of the retention basin, the drawdown time (T) may be estimated very simply. Percolation or infiltration in a retention basin produces an infiltration hydrograph (time-variable) that describes the draining of the basin. The rate of outflow will be in accordance with Darcy's equation, that is:

$$q = KiA \quad \text{where:}$$

q = rate of seepage or percolation from the facility (ft^3/hr)
K = hydraulic conductivity or percolation rate associated with the soil in the vicinity of the facility (ft/hr)
i = hydraulic gradient or the loss of hydraulic head per unit distance of flow (ft/ft)
A = area of the soil profile through that infiltration is occurring (ft^2)

When the water table is below the bottom of the basin, the entire surface area of the facility is available for percolation. The average area (A) may be determined by dividing the volume by the depth of the holding area. Assuming a hydraulic gradient of unity (e.g., i = 1), that is a conservative assumption, the rate of outflow may be calculated once the permeability (K) is established using appropriate field testing procedures.

Stormwater Retention Basins (SRB) (Cont'd)

The final or constant rate established from these testing procedures must be used, not the initial rate encountered shortly after the beginning of a test run.

Subsequently, drawdown time (T) may be determined by dividing the storage volume (V_m) required for the facility (e.g., one-half inch runoff volume or other appropriate value) by the rate of percolation from the facility as established from Darcy's formula. The appropriate expression is shown below where all terms are as previously discussed in this paragraph.

$$T = V_m/q$$

There are many areas in Kentucky where retention is not an economically feasible alternative. The most common limitations are restrictive soil layers in combination with flat terrain, poorly defined surface drainage systems, and limited elevation differences that severely restrict the movement of water. In most instances, designers elect to use filters and underdrains to provide the prescribed level of stormwater quality treatment.

Surveys and Investigations Required

At a minimum, it will be necessary to determine the infiltration rate of local soils. This information is needed to evaluate drawdown time. Provided the location of the treatment facility is flexible, this type of data is also valuable for situating the facility where it may function the most advantageously.

To develop a discharge-time relationship for the drainage area, sufficient topographic information and data pertaining to the type and condition of the vegetative cover at the site must be available in order to estimate the time of concentration of the watershed.

The site survey should be in sufficient detail to allow the permitting authority to be able to fully assess the potential for groundwater contamination that may be associated with a proposed project. In most cases, the applicant should be prepared to submit:

1. Geologic sections describing the substrate through the retention basis area.

2. A description of all groundwater levels and flow at the site.

Stormwater Retention Basins (SRB) (Cont'd)

3. A description of the site's topography before and after the project construction including information on any surface water drainage.

4. An inventory of existing wells within a 1,000-foot radius of the stormwater basin.

SPECIFICATIONS

Construction and Design Considerations

1. General. A schematic or an off-line retention basin with an overflow spillway is shown in Figure 2.

   Regardless of the type of infiltration system to be constructed, careful consideration should be given to the effects that the design work sequence, construction techniques, and equipment employed will have on future operation and maintenance of the system. Serious problems can be averted, or in large part mitigated, by the adoption of relatively simple measures during the design and construction phase.

2. Surface Percolation (Retention Basin) - The sequence of various phases of basin construction has an identifiable relationship to the overall project construction schedule. An ideal program would schedule rough excavation of the basin for the rough grading phase of the project to permit use of the material as fill in earthwork areas. The partially excavated basin may serve as a sediment basin BMP to assist in erosion control during construction. Stormwater from untreated, freshly constructed slopes within the watershed area will load the newly formed basin with a heavy concentration of fine sediment. Such circumstances seriously impair the natural infiltration characteristics of the site.

   A dense stand of vegetation will not only prevent erosion, but will also provide a natural means of maintaining relatively high infiltration rates through the surface. When the basin is adequately maintained, removal of any accumulated sediment is a problem only at the basin floor. Little, if any additional maintenance is required to maintain the infiltration capacity of the slope areas.

   In design, prevention of scour at the basin inlet is mandatory to reduce maintenance problems and aid in establishing vegetation. Reduction in water energy by providing hydraulic structures and an apron on that water can flow into the basin are effective in reducing scour.

Stormwater Retention Basins (SRB) (Cont'd)

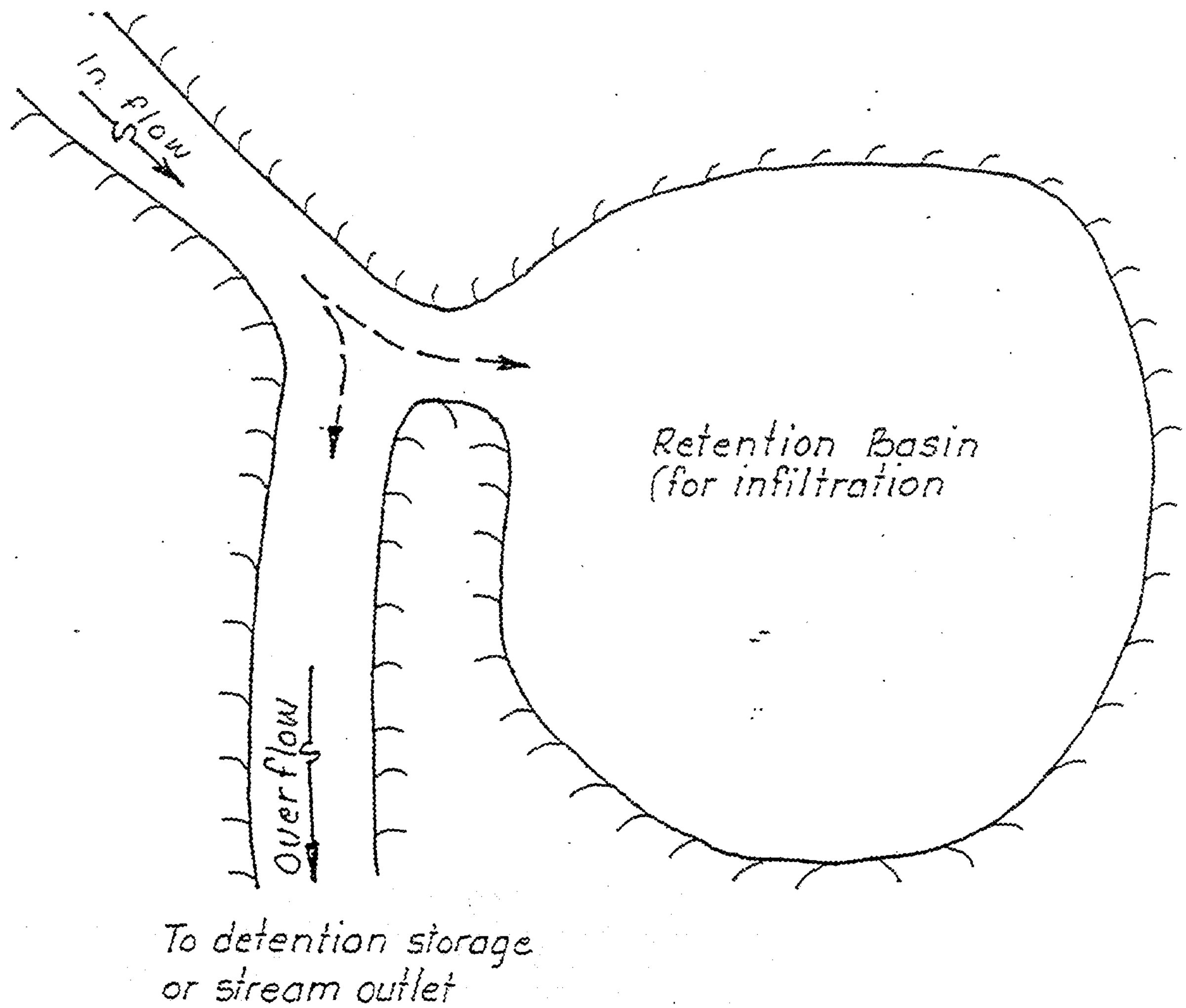


Figure 2
Off-line retention basin arrangement.

Stormwater Retention Basins (SRB) (Cont'd)

If possible, after excavation or earth moving for basin construction, runoff waters should not be permitted to flow into the basin until vegetation cover has been established.

Maintenance of side slope is important. Recommended using slopes of 3 horizontal to 1 vertical or flatter to facilitate mowing and maintenance. Basin shape depends largely on the configuration of the available site. The shape providing the greatest area will infiltrate water most rapidly.

Initial basin excavation should be carried to within 1 ft. (0.3 m) of the final elevation of the basin floor. Final excavation to the finished grade should be deferred until all slopes in the watershed have been seeded and protected with an interim treatment. The final phase excavation should be performed carefully to remove all accumulated sediment.

Relatively light equipment is recommended for this operation to avoid deep compaction of the basin floor. After the final grade is completed, the basin floor should be deeply tilled with rotary tillers or disc harrows to open the soil pores and provide a well-aerated, highly porous surface texture for seeding or sodding.

As noted earlier, detention or sediment basins can be used prior to retention basins so that suspended solids will settle out before the water is released into the retention basin. These basins must be large enough to hold storm runoff for a sufficient settlement time. This could vary from one or two hours to a day or more depending on soil type and particle size. Where the soil contains considerable amounts of fine textured material of low settling velocity, a sediment basin may be larger and shallower than the actual retention basin.

Landscaping of retention basin facilities creates a pleasing appearance that should always be considered when basins are located near residential areas. The landscaped basins can be used as a park or recreation area. However, such a project requires plants, trees and shrubs capable of withstanding temporary inundation. Basin sides should be gently sloped to give a park-like appearance.

Stormwater Retention Basins (SRB) (Cont'd)

Infiltration basins are sometimes lined with material to help prevent the build-up in impervious silt deposits on the soil surface. A 6-inch (0.15m) layer of pea gravel on the basin floor can serve to effectively screen out suspended solids and keep infiltration rates high. The gravel layer can be replaced or cleaned when it becomes clogged. However, planting of grass is probably a more economical alternative. Vegetation has been shown to extend infiltration efficiency, keep the soil pervious, reduce maintenance due to clogging, and prevent erosion.

Grass serves as a good filter material. Well-established fescue on a basin floor will grow up through silt deposits forming a porous turf and thus prevent the formation of an impermeable layer. Grass infiltration works well with long narrow basins along the fringes of parking areas and highways. Bermuda requires little attention.

Coarse organic material (such as sawdust, leaves, stems, etc.) is sometimes specified for disking or spading into the basin floor to increase the permeability of clayey soils.

The basin floor should be soaked or inundated for a brief period then allowed to dry subsequent to this operation. This is thought to induce the organic material to decay rapidly, loosening the upper soil layer.

Maintenance and Inspection

1. General - All stormwater systems should be inspected on a routine basis to ensure that they are functioning properly. Major inspections can be on an annual or semi-annual basis, but brief inspections should always be conducted following major storms. Systems that incorporate infiltration are most critical since poor maintenance practices can soon render them inefficient. Procedures for maintenance of these system are discussed in this section. It should be stressed that good records should be kept on all maintenance operations to help plan future work and identify facilities requiring attention. It is also advisable to follow up with site visit to assure that vegetation (sod) is growing well and that all construction is according to approved design.

2. Retention Basins - Retention basin surfaces are sometimes scarified to break up silt deposits and restore topsoil porosity. This should be accomplished after all sediment has been removed from the basin floor. However, this operation can be eliminated or minimized by the establishment of grass cover on the basin floor and slopes. Such cover helps maintain soil permeability.

Stormwater Retention Basins (SRB) (Cont'd)

Holding ponds or sedimentation basins can be used to reduce maintenance in conjunction with retention basins by settling out suspended solids or removing oil and grease before the water is released into the retention basin.

Cleanout frequency of retention basins will be a function of their storage capacity, infiltration characteristics, volume of inflow, and amount and type of sediment load. Retention basins should be thoroughly inspected at least once a year. Sediment basins and traps may require more frequent inspections and cleanout. These structures should have a prescribed sediment level at that they are cleaned.

WATER MANAGEMENT, EROSION AND
SEDIMENT CONTROL FOR CONSTRUCTION AREAS

TECHNICAL STANDARD AND SPECIFICATIONS

Pipe Structures (SPS) Straight Pipe Structures
(DPS) Drop Pipe Structures

Definition

A structure installed to safely conduct runoff water from the top to bottom of a slope or lower water from a waterway into an open channel.

Purpose

To prevent erosion of slopes and channel banks by preventing high-velocity flows.

Conditions Where Practice Applies

This practice applies to sites where earth and vegetation cannot safely handle water at permissible velocities, where excessive grades or overfall conditions are encountered, or where water is to be structurally lowered from one elevation to another. These structures should be planned and installed along with or as a part of other conservation practices in an overall surface water disposal system.

This standard does not apply to storm sewers, concrete overfall structures, in channel grade control structures, or road culverts.

Design Criteria

Design and specifications shall be prepared for each structure on an individual job basis depending on its purpose and site conditions. The type of materials should be considered in the design for each site to ensure that the structure fulfills its intended purpose.

Capacity

The minimum design capacity for pipe structures shall be as required to pass the peak runoff expected from a 24-hour, 2-year frequency storm. Runoff will be computed by the method outlined in Chapter 2, Engineering Field Manual for Conservation Practices, SCS, or by other acceptable methods. Runoff computation will be based upon the most severe soil and cover conditions that will exist in the area draining into the pipe structures during the planned life of the structure.

Pipe Structures (SPS) (DPS) (Cont'd)

All pipe structures should be designed as island types with an emergency spillway to safely pass storms larger than the structure design storm. The minimum total capacity of the principal and emergency spillways shall be that required to handle the 25-year frequency, 24-hour duration storm.

General

The planning and design of antivortex devices, trash racks, anti-seep collars and outlet protection should be in accordance with the requirements of TEMPORARY SEDIMENT BASIN, pipe spillway design.

Straight pipe structures should be built in accordance with Figure 1.

Pipe drop structures should be built in accordance with Figure 2.

The crest elevation for the emergency spillway shall be set at the minimum level necessary to ensure full flow of the principal spillway. The top of the settled embankment shall be based on 1 foot of freeboard above the design flow depth in the emergency spillway.

SPECIFICATIONS

The structure shall be placed in undisturbed soil or well-compacted fill. Backfill shall be placed in 4-inch layers and hand compacted to ensure adequate compaction.

The embankment shall be constructed according to the specifications for sediment basin embankments.

Protective measures of concrete or riprap shall be installed at the inlet and outlet as needed to protect against erosion.

The embankment and all disturbed areas shall be seeded, fertilized, and mulched according to the specifications for Permanent Seeding.

Pipe Structures (SPS) (DPS) (Cont'd)

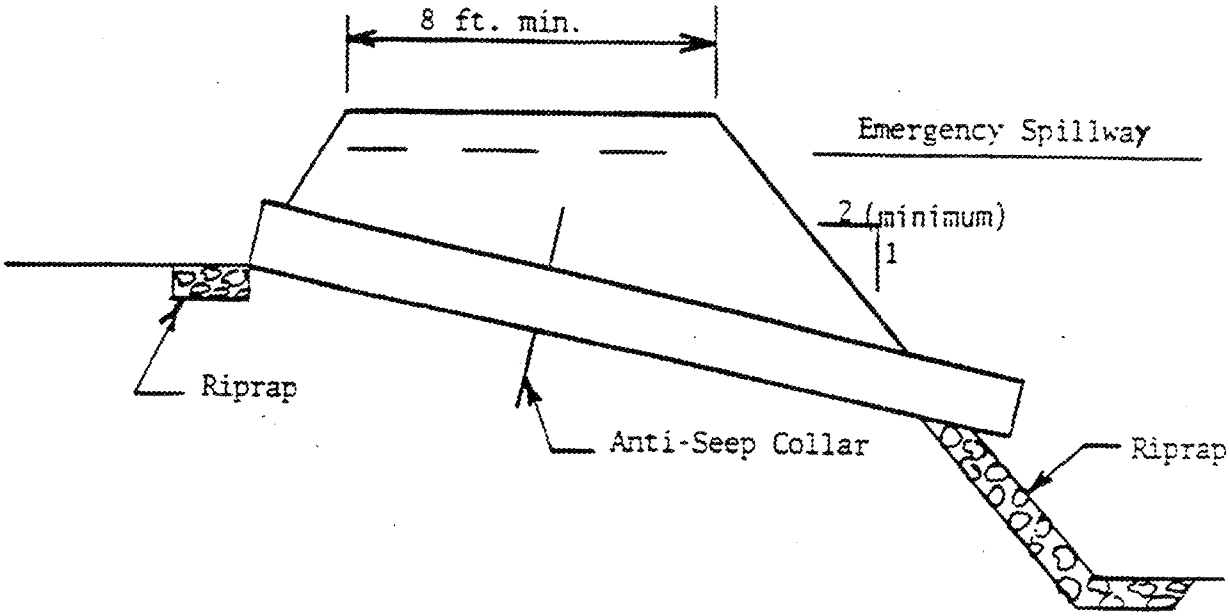


Figure 1. Straight Pipe Structure

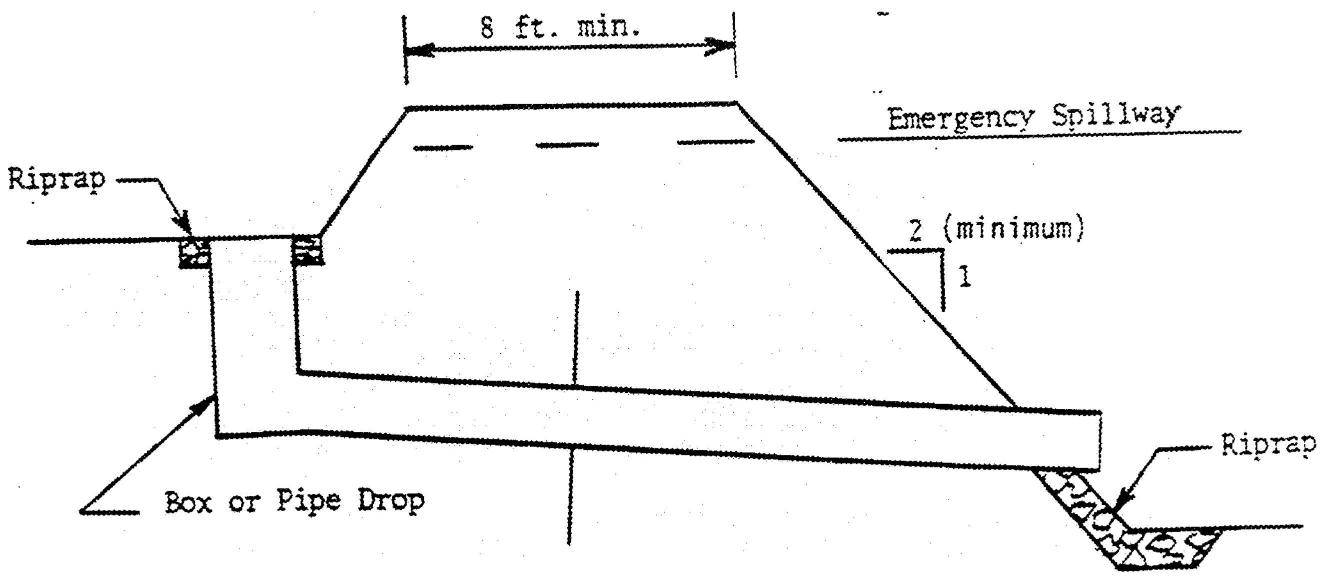


Figure 2 Pipe Drop Structure

WATER MANAGEMENT, EROSION AND
SEDIMENT CONTROL FOR CONSTRUCTION AREAS

TECHNICAL STANDARD AND SPECIFICATIONS

Outlet Protection (OP)

Definition

Structurally lined aprons (pads) or other acceptable water energy dissipating devices placed at the outlets of pipes or paved channel sections.

Purposes

To prevent scour at stormwater outlets and to minimize the potential for downstream erosion by reducing the velocity of concentrated stormwater flows.

Conditions Where Practice Applies

Applicable to the outlets of all pipes and paved channel sections flow where the velocity of flow at design capacity of the outlet will exceed the permissible velocity of the receiving channel or area. To prevent scour at stormwater outlets, a flow transition structure is needed that will absorb the initial impact of the flow and reduce the flow velocity to a level that will not erode the receiving channel or area.

Design Criteria

Structurally lined aprons at the outlets of pipes and paved channel sections shall be designed according to the following criteria:

Pipe Outlets

Tailwater - The depth of tailwater immediately below the pipe outlet must be determined for the design capacity of the pipe. Manning's Equation may be used to determine tailwater depth. If the tailwater depth is less than half the diameter of the outlet pipe, it shall be classified as a Minimum Tailwater Condition. Pipes that outlet to flat areas with no defined channel may be assumed to have a Minimum Tailwater Condition.

Apron Length - The apron length shall be determined from Figure 3 or 4 according to the tailwater condition.

Apron Width - If the pipe discharges directly into a well-defined channel,(Figure 1) the apron shall extend across the channel bottom and up the channel banks to an elevation 1 foot above the maximum tailwater depth or to the top of the bank (whichever is less).

Outlet Protection (OP) (Cont'd)

If the pipe discharges onto a flat area with no defined channel, (Figure 2) the width of the apron shall be determined as follows:

a. The upstream end of the apron, adjacent to the pipe, shall have a width three times the diameter of the outlet pipe.

b. For a Minimum Tailwater Condition, the downstream end of the apron shall have a width equal to the pipe diameter plus the length of the apron from the curves. (Figure 3)

c. For a Maximum Tailwater Condition, the downstream end shall have a width equal to the pipe diameter plus 0.4 times the length of the apron from the curves. (Figure 4)

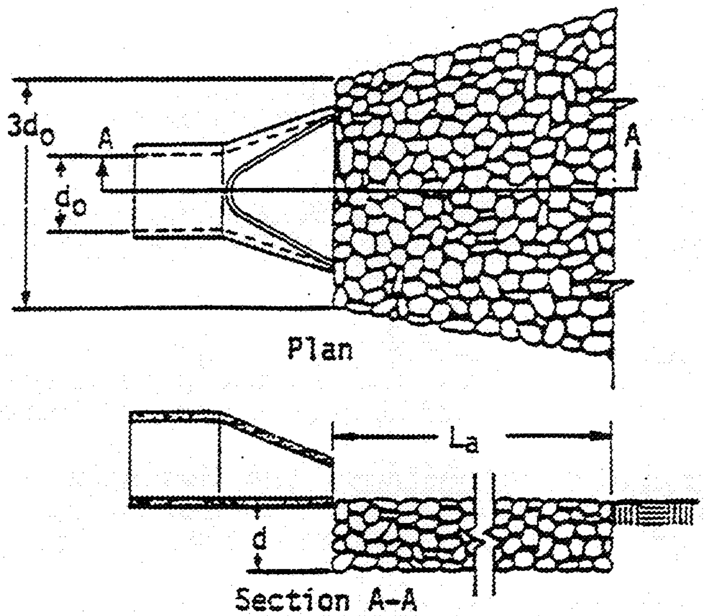
Bottom Grade - The apron shall be constructed with no slope along its length (0.0 percent grade). The invert elevation of the downstream end of the apron shall be equal to the elevation of the invert of the receiving channel. There shall be no overfall at the end of the apron.

Side Slope - If the pipe discharges into a well-defined channel, the side slopes of the channel shall not be steeper than 2:1 (Horizontal:Vertical).

Alignment - The apron shall be located so that there are no bends in the horizontal alignment.

Materials - The apron may be lined with riprap, grouted riprap, or concrete. The median sized stone for riprap shall be determined from the curves on Figure 3 and 4 according to the tailwater condition. The gradation, quality, and placement of riprap shall conform to Standard and Specification, Riprap.

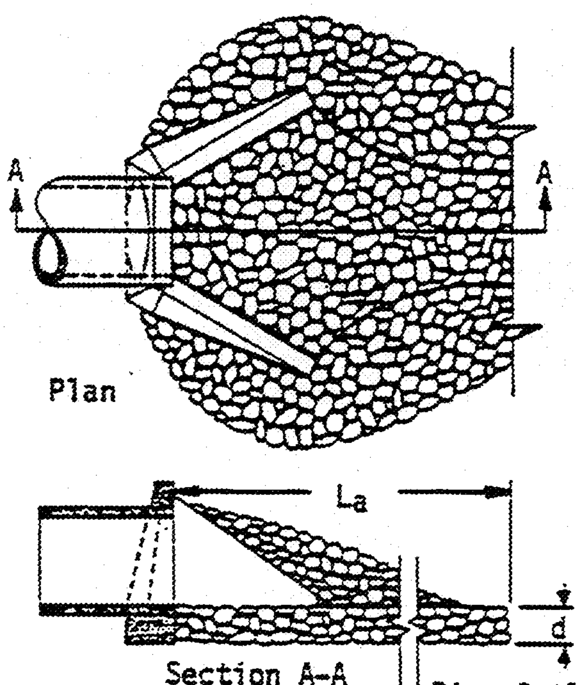
Outlet Protection (OP) (Cont'd)



Pipe Outlet To Flat Area
With No Defined Channel

Notes

1. Apron lining may be riprap, grouted riprap, or concrete.
2. L_a is the length of the riprap apron as calculated using Plates 1.36d and 1.36e.
3. d = 1.5 times the maximum stone diameter but not less than 6 inches.



Pipe Outlet To Well-Defined Channel

Figure 1

Outlet Protection (OP) (Cont'd)

PAVED CHANNEL OUTLETS

1. The flow velocity at the outlet of paved channels flowing at design capacity must not exceed the permissible velocity of the receiving channel.

2. The end of the paved channel shall merge smoothly with the receiving channel section. There shall be no overfall at the end of the paved section. Where the bottom width of the paved channel is narrower than the bottom width of the receiving channel, a transition section shall be provided. The maximum side divergence of the transition shall be 1 in 3F where;

$$F = \frac{V}{\sqrt{gd}}\text{ , and}$$

F = Froude number
V = Velocity at beginning of transition (ft./sec.)
d = depth of flow at beginning of transition (ft.)
g = 32.2 ft./sec.^{2}

3. Bends or curves in the horizontal alignment of the transition are not allowed unless the Froude number (F) is 0.8 or less, or the section is specifically deigned for turbulent flow.

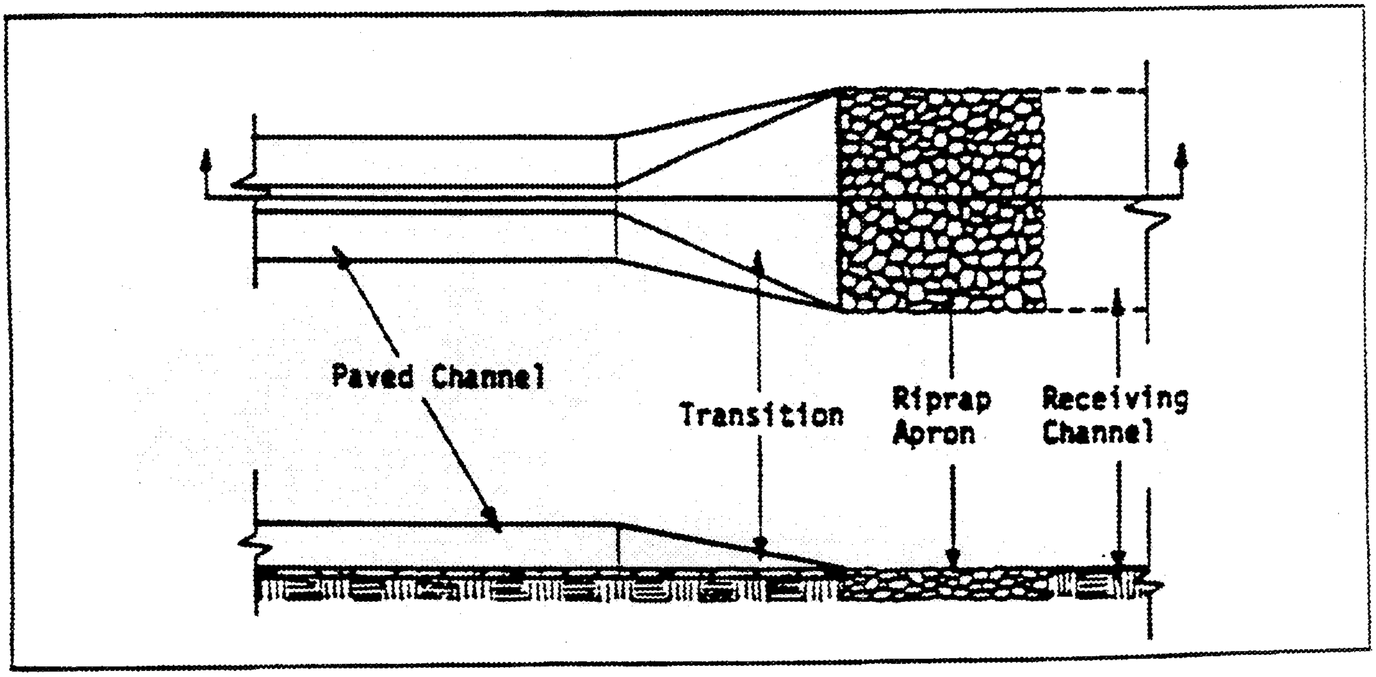
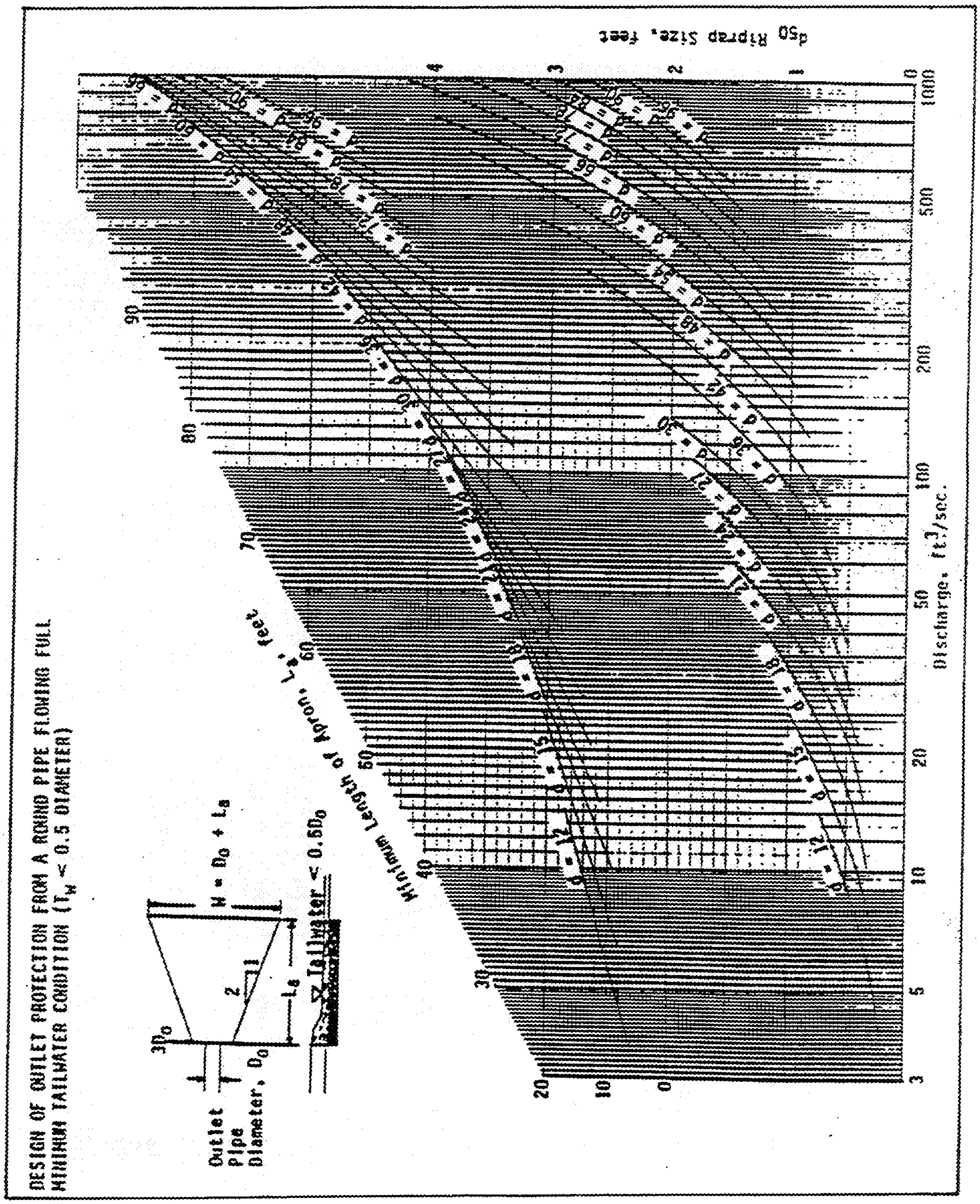


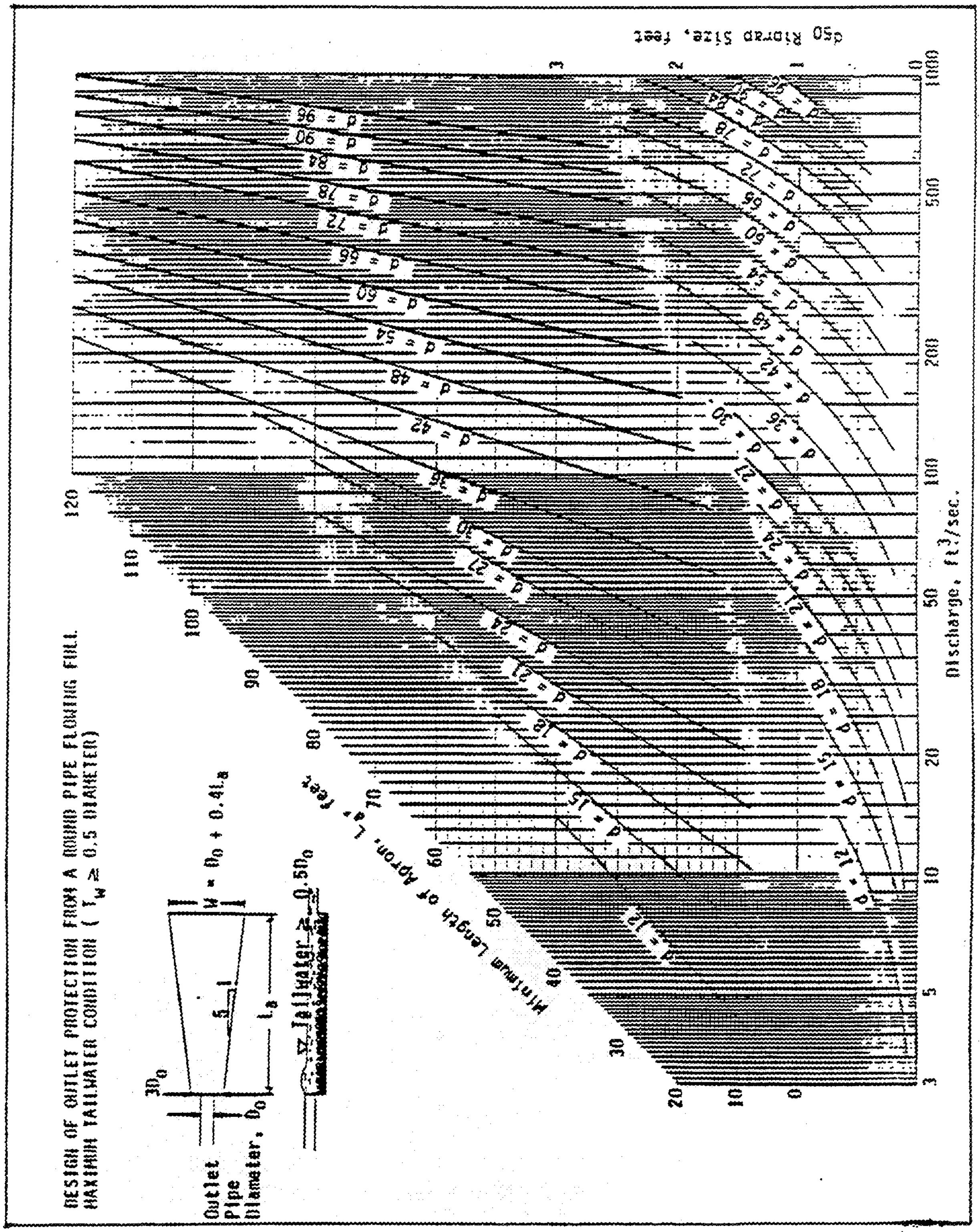
Figure 2

Outlet Protection (OP) (Cont'd)



Source: USDA-SCS Figure 3

Outlet Protection (OP) (Cont'd)



Source: USDA-SCS Figure 4

Outlet Protection (OP) (Cont'd)

<u>Example 1:</u> <u>Outlet Protection Design</u>

Given: An 18-inch pipe discharges 24 $ft.^3/sec.$ at design capacity onto a grassy slope (no defined channel).

Find: The required length, width and median stone size (d_{50}) for a riprap-lined apron.

Solution:

1. Since the pipe discharges onto a grassy slope with no defined channel, a <u>Minimum Tailwater Condition</u> may be assumed.

2. From Figure 3, an apron length (L_a) of <u>20 feet</u> and a median stone size (d_{50}) of 0.8 ft. are determined.

3. The upstream apron width equals three times the pipe diameter; 3x 1.5 ft. = <u>4.5 ft.</u>

4. The downstream apron width equals the apron length plus the pipe diameter; 20 ft. + 1.5 ft. = <u>21.5 ft.</u>

<u>Example 2:</u>

Given: The pipe in example No. 1 discharges into a channel with a triangular cross section, 2 feet deep and 2:1 side slopes. The channel has a 2% slope and an "n" factor of 0.045.

Find: The required length, width and the median stone size (d_{50}) for a riprap lining.

Solution:

1. Determine the tailwater depth using Manning's Equation.

$$A = \frac{1.49}{n} R^{2}\,/^{3} \quad S^{1}\,/^{2} \quad A$$

$$24 = \frac{1.49}{0.045} \quad \frac{2d}{2\ {}^{2} + 1}\ {}^{2}/{}^{3} \ (0.02)\ {}^{1}/{}^{2} \quad (2d^{2})$$

where,

d = depth of tailwater
d = 1.74 ft.*

*Since d is greater than half the pipe diameter, a <u>Maximum Tailwater Condition</u> exists.

Outlet Protection (OP) (Cont'd)

2. From Figure 4, a median stone size ($_{50}$) of 0.5 ft. and an apron length (L_a) of 41 ft. is determined.

3. The entire channel cross section should be lined, since the maximum tailwater depth is within 1 foot of the top of the channel.

SPECIFICATION

Subgrade Preparation

The subgrade for the riprap or filter shall be prepared to the required lines and grades. Any fill required in the subgrade shall be compacted to a density approximately that of the surrounding undisturbed material. Brush, trees, stumps, and other objectionable material shall be removed.

Stone Placement

Placement of riprap should follow immediately after subgrade preparation. The riprap should be placed so that it produces a dense well-graded mass of stone with a minimum of spaces. The stones to distribute throughout the protected area may be obtained by selective loading at the quarry, controlled dumping of successive loads during final placing, or by a combination of these methods. The riprap should be placed to its full thickness in one operation, not in layers. The riprap should not be placed by dumping into chutes or similar methods that are likely to cause segregation of the various stone sizes. Care should be taken not to dislodge the underlying material when placing the stones. Some hand placing may be necessary to achieve the required grades and a good distribution of stone sizes.

TECHNICAL STANDARD AND SPECIFICATIONS

Paved Flume (PF)

Definition

A permanent lined channel constructed on a slope.

Purpose

To conduct stormwater runoff safely down the face of a slope without causing erosion problems on or below the slope.

Conditions Where Practice Applies

Wherever concentrated stormwater runoff must be conveyed from the top to the bottom of cut or fill slopes on permanent basis. Also, where shallow road ditches are released into deeper open ditches or catch basins.

Planning Considerations

These structures should be planned and designed along with, or as a part of, other conservation practices in an overall surface water disposal system.

Paved flumes or gutters are used routinely on highway cuts and fills to convey concentrated stormwater runoff from the top to bottom of a slope without erosion. The Kentucky Department of Highways has developed standards and specifications for these structures that may also be applicable to cut and fill slopes for construction projects other than highways. These standard drawings and design procedures may be used where applicable.

Design Criteria

Design and specifications shall be prepared for each structure on an individual job basis depending on its size and site conditions. The following criteria apply to all flume designs:

1. Flumes can be constructed of concrete or riprap. Concrete flumes shall have a minimum thickness of six (6) inches. Riprap flumes shall be a minimum thickness of 1.5 times the maximum stone diameter but not less than 8 inches.

2. The maximum slope of the structure shall be 2:1.

3. Cutoff walls shall be constructed at the beginning and end of every flume except where the flume connects with a catch basin or inlet.

Paved Flume (PF) (Cont'd)

Capacity

Paved flumes shall be capable of passing the peak flow expected from a 10-year, 24-hour, frequency storm.

Cross Section

The required flow capacity along with the slope will determine the cross sectional area required for the site. Three cross sections commonly used for construction sites are shown in Figure 1 of the specification. Other cross sections may be used when supported by applicable design procedures and computations.

Outlet

Outlets of paved flumes shall be protected from erosion. The specification for Outlet Protection should be used to provide this protection. For large flume designs, it may be necessary to design a larger energy dissipator at the outlet.

SPECIFICATIONS

1. The subgrade shall be constructed to the required elevations. All soft sections and unsuitable material shall be removed and replaced with suitable material. The subgrade shall be thoroughly compacted and shaped to a smooth, uniform surface. For concrete flumes, the subgrade shall be moist at the time the concrete is placed.

2. Construction and expansion joints shall be used on long concrete flumes. Sawed or impressed contraction joints shall be spaced at 10-foot intervals.

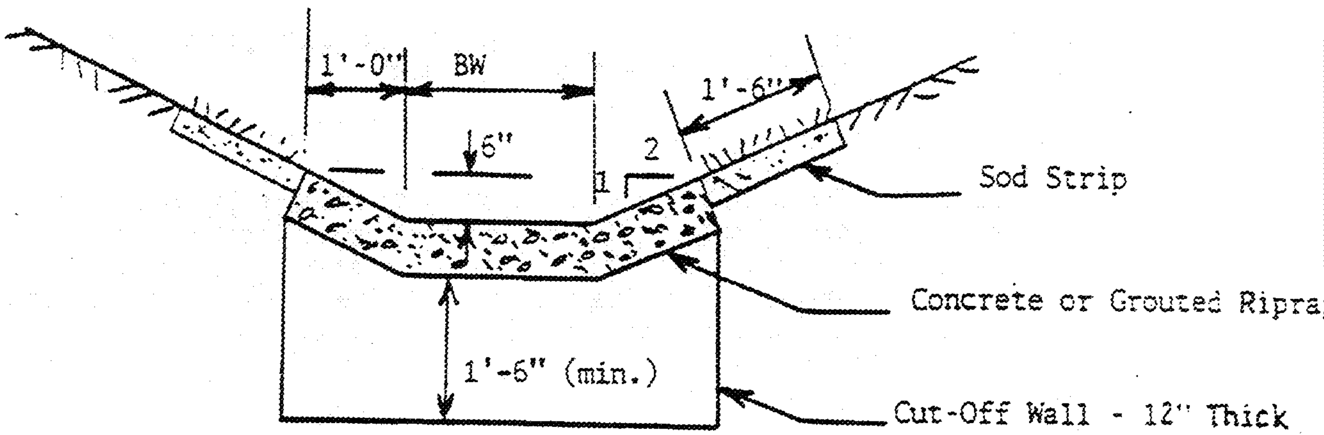
3. The construction specifications for riprap shall be used for all riprap flumes.

Maintenance

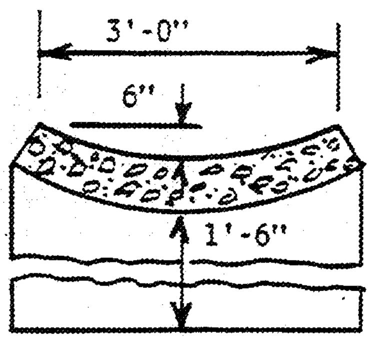
Before permanent stabilization of the slope, the structure should be inspected after each rainfall, and damages to the slope or paved flume repaired immediately. After the slope is stabilized, little maintenance should be required.

Paved Flume (PF) (Cont'd)

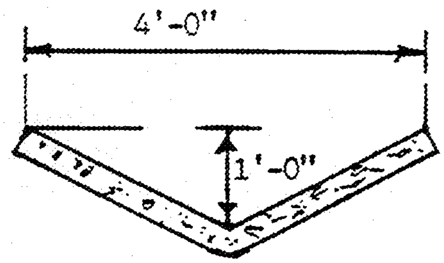
TYPICAL PAVED FLUMES



TRAPEZOIDAL



PARABOLIC



"V" BOTTOM

Figure 1

Water Bar (WB)

Definition

A ridge of compacted soil or loose rock or gravel constructed across disturbed rights-of-way and similar sloping areas.

Purpose

To shorten the flow length within a long, sloping right-of-way such as roads and utilities lines, thereby reducing the erosion potential by diverting storm runoff to a stabilized outlet or sediment trapping device.

Conditions Where Practice Applies

Generally, earthen diversions are applicable where there will be little or no construction traffic within the right-of-way. Gravel structures are more applicable to roads and other rights-of-way that accommodate vehicular traffic.

Planning Considerations

Construction of utility lines and roads often requires the clearing of long strips of right-of-way over sloping terrain. The volume and velocity of stormwater runoff tend to increase in these cleared strips and the potential for erosion is much greater since the vegetative cover is diminished or removed. To compensate for the loss of vegetation, it is usually a good practice to break up the flow length within the cleared strip as that runoff does not have an opportunity to concentrate and cause erosion. At proper spacing intervals, water bars can significantly reduce the amount of erosion that will occur until the area is permanently stabilized.

Design Criteria

1. Drainage Area - Less than 1.0 acre.

2. Dimensions

   The minimum allowable height measured from the channel bottom to the ridge top is 18 inches. The minimum top width shall be 1.5 feet, and the base width minimum is 6 feet.

3. Side Slopes

   3:1 or flatter to allow the passage of construction traffic.

Water Bar (WB) (Cont'd)

4. Width

The measure should be constructed completely across the disturbed portion of the right-of-way.

5. Spacing

The following table (Table 1) will be used to determine the spacing of water bars on right-of-way less than 100 feet wide:

Table 1

Percent Slope	Spacing (ft.)
Less than 5%	125
Between 5% and 10%	80
Between 10% and 20%	50
Greater than 20%	30

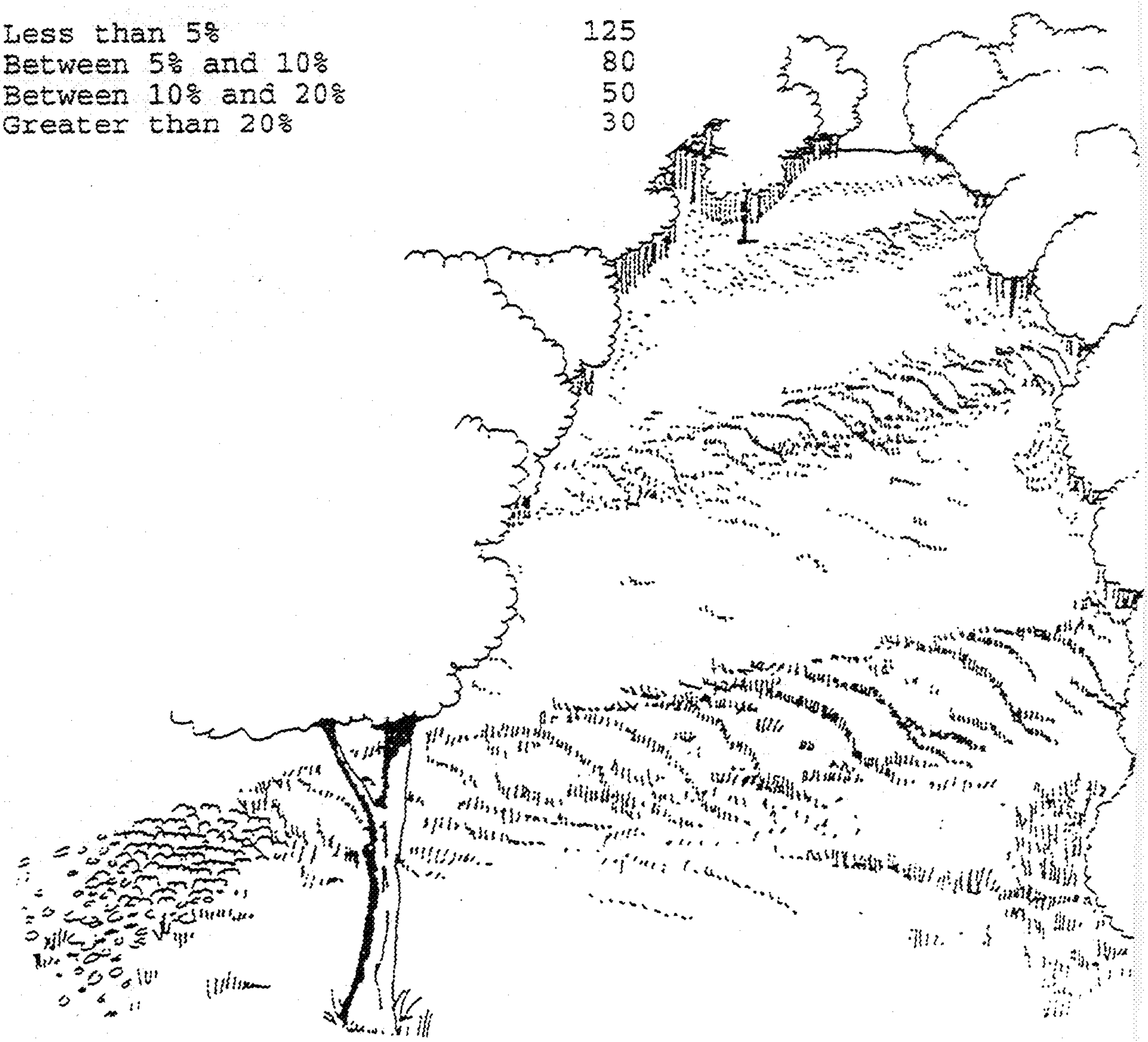


Figure 1

Water Bar (WB) (Cont'd)

6. Grade

   Positive drainage installed at a 30-degree angle across the right-of-way should be provided to a stabilized outlet or sediment trapping facility.

7. Outlet

   Interceptor dikes must have an outlet that is not subject to erosion. The on-site location may need to be adjusted to meet field conditions to utilize the most suitable outlet. Concentrated flows should be spread over the widest possible area after release. Flows with high sediment concentrations should pass through a sediment trapping measure.

SPECIFICATIONS

1. The diversion shall be installed as soon as the right-of-way has been cleared and/or graded.

2. All earth fill shall be machine- or hand-compacted in 6-inch lifts.

3. The outlet of the diversion shall be located on an undisturbed and stabilized area when at all possible. The field location should be adjusted as needed to utilize a stabilized outlet. Sediment laden flows shall be conveyed to a sediment trapping device.

4. Water bars that will not be subject to construction traffic should be stabilized in accordance with TEMPORARY SEEDING.

Maintenance

The practice shall be inspected after every rainfall and repairs made if necessary. Approximately once every week, whether a storm has occurred or not, the measure shall be inspected and repairs made if needed. Earth fill that is subject to damage by vehicular traffic should be re-shaped at the end of each working day.

WATER MANAGEMENT, EROSION AND
SEDIMENT CONTROL FOR CONSTRUCTION AREAS
TECHNICAL STANDARD AND SPECIFICATION

Pesticide And Chemical Application (PCA)

Definition

Eliminating excessive pesticide chemical use by proper application procedures and/or use of alternatives to chemical pest control.

Purpose

To reduce the pesticide load in stormwater runoff; and to reduce the potential harm to plant and animal life resulting from chemicals in the waterways.

Conditions Where Practice Applies

This practice applies to those areas of construction sites where pesticide chemicals are used to enhance plant growth, while killing insect, weeds, and other pests.

The term "pesticide" is defined broadly to cover chemicals used against pests of all kinds: insecticides to kill insects; herbicides to kill weeds, brush or unwanted vegetation; fungicides to control fungi that cause molds, rots, and plant and animal diseases; nematicide to kill nematodes, the minute eel worms that attack plant roots; and rodenticides to kill rats and other rodents.

Planning Considerations

Caution in the use of pesticides and other chemicals cannot be over-emphasized. Pesticides are poisons and may be more likely to be overused or misused than other pest control methods. They can cause a significant water quality problem when washed off the soil and into the waterways.

On the land, improper use of pesticides can alter the food chains of animals, can have a detrimental effect on unintended pests, and may shift the problems of pest control from one plant life to another - to name just a few hazards. Pesticides that wash off the land into the waterways can cause acute toxicity or alteration in the food chain of fish and plant life, and can also pass through conventional waste treatment plants, killing the very bacteria that are essential to break down other wastes and pollutants.

Pesticide And Chemical Application (PCA) (Cont'd)

SPECIFICATIONS

General

- Other factors being equal, the least toxic chemical that will accomplish the purpose should be used.
- Taking this one step further, it should be determined whether the pesticide is necessary (the side effects may outweigh the elimination of the pest!), or if alternatives to pesticides may be used with equal effectiveness.
- Pesticides that degrade rapidly are less likely to cause severe water pollution.
- Some pesticide formulations have a broad spectrum of activity; these should be used whenever possible, instead of applications of highly specific material.
- Before application of pesticides, environmental considerations should include: weather and other climatic conditions; types of terrain, soil and other substrate; presence of fish, wildlife and other non-target organisms; and drainage patterns of the areas.
- The manufacturer's recommended dosage should never be exceeded; if anything, less than the recommended amount should be used.

Materials and Methods of Application

Dust, sprays, fumigants, preplant treatments, granular formulations, and antimicrobial paints and other surface coatings are types of applications that may be used. Timing, weather conditions, and topography must be considered when choosing the physical form of a pesticide chemical and the way to apply it.

Protection of Water Sources

Surface water, groundwater, and pipeline systems should be protected when preparing, using and cleaning up pesticide chemicals.

Pesticide And Chemical Application (PCA) (Cont'd)

For lakes and streams, equipment should not be driven into the waterways for filling and cleaning; if the equipment must be filled at the lake or stream, only a suction line should be placed in the water. Equipment flushing should be done in an area where runoff from pesticides can be avoided.

For groundwater, toxic chemicals should not be placed on the soil where they can contaminate subsurface water through percolation or rock fissure. Pits used for dumping flush water should be impervious enough to prevent percolation of pesticides into the ground. Groundwater contamination could occur through a pressurized system using a well as a supply. Anti-backflow devices should be used on hose connections if the hose will come in contact with chemicals during mixing and filling operations.

Disposal of Unused Pesticides

Some county governments have sponsored a county-wide collection where citizens may drop off any unused pesticides for safe disposal. Call your courthouse to find out if such a collection is scheduled for your area. If one is not, depending upon the manufacturer's recommendations on the label, other disposal methods include:

(1) incineration at appropriate temperatures and under correct atmospheric conditions;
(2) burial in a specifically designed landfill; and
(3) chemical methods that degrade or detoxify the pesticides into non-hazardous forms.

Specific help may be obtained from the Kentucky Department of Agriculture, Division of Pesticides, and Natural Resources and Environmental Protection Cabinet, Division of Waste Management.

In accordance with established regulations, excess pesticides should never be disposed of by open dumping, open burning, or dumping in waterways.

The most effective way to minimize hazards from disposal is to prevent the accumulation of a surplus. Careful planning of needs should be made before pesticides are purchased; these purchases should be limited to a one-year or one-season supply. Mix only what is needed and when it is needed to avoid unnecessary surplus.

Pesticide And Chemical Application (PCA) (Cont'd)

Disposal of Containers

Containers should drain in a vertical position for at least 30 seconds after normal emptying, after that they should be rinsed three times with water or other diluting material. Suggested dilution ratios are one quart of water or diluting material for each gallon container; one gallon for five-gallon containers; and five gallons for 30- or 55-gallon drums. Containers should drain for at lest 30 seconds after each rinse, and the rinse should be drained into the spray tank.

Pesticide containers should never be reused; therefore, they should be punctured and crushed before disposal. Disposal may include burying in designated landfills or recycling as scrap metal. In some instances, the container may be returned to the pesticide manufacturer. Instructions on the product label may also have recommendations for disposal (or return of the container).

In addition, it should be kept in mind that no pesticide container can be washed entirely free of residue, and that a small amount of residue can be a source of water pollution.

The Kentucky Department of Agriculture, Division of Pesticides, and/or the Kentucky Division of Waste Management, NREPC, may be consulted for special instructions and other information.

Storage of Unused Pesticides

Although different chemicals may require special storage facilities, in general these guidelines should be followed:

- The storage site should be well ventilated and insulated from extreme heat, cold and moisture.

- The storage facility should not be subject to flooding, and should be constructed so that any leakage of containers will not be subject to runoff in streams.

- The facility should provide for security to prevent non-qualified persons from dispensing the chemicals.

- Guidelines for length of storage and type of facility for storage, as recommended by the manufacturer, should be followed.

Pesticide And Chemical Application (PCA) (Cont'd)

Legal Requirements and Additional Assistance

Legally, the Federal Insecticide, Fungicide and Rodenticide Act of 1972 (P.L. 92-516), as amended in 1975 and 1978, sets general and specific standards. Commercial applicators should be familiar with this law and its regulations pertaining to certification and proper use of general restricted pesticides. These persons should also be familiar with the state law (Kentucky Pesticide Use and Application Act of 1978) outlining certification procedures, as well as Kentucky Revised Statute 217B.

Because of the complexity of pesticide applications, government regulations, the large number of available pesticides, alternate control methods, and disease-resistant crops, further information on specific recommendations may be obtained from the University of Kentucky Cooperative Extension Service. For information on state regulations contact the Kentucky Department of Agriculture, Division of Pesticides, 100 Fair Oaks Lane, Frankfort, Kentucky 40601, or call (502)564-7274.

SOME ALTERNATIVE METHODS OF PEST CONTROL: These are alternatives to chemicals for pest control, all of that are based on natural means. These include:

- biological control (based on killing pests through bacteria or disease)
- mechanical controls (such as bug lights); and
- eradication of alternate hosts (breaking the life cycle of the host species)

Encompassing all of the above concepts is an approach called integrated pest management, or I.P.M. This system utilizes all available control measures, taking into account the number of pests in the environment and the interrelationship among pests and other factors.

There are three main concepts in an I.P.M. system, that include:

(a) manipulation of natural control by cultural methods to prevent pest buildup;
(b) survey and early detection of injurious species and the need for control measures; and
(c) using the most effective technique or combination of control techniques when necessary to prevent environmental damage.

WATER MANAGEMENT, EROSION AND
SEDIMENT CONTROL FOR CONSTRUCTION AREAS

TECHNICAL STANDARD AND SPECIFICATIONS

Fertilizer Application Control (FAC)

Definition

Managing the use of fertilizer in order to keep it on the land.

Purpose

To prevent fertilizer nutrients from reaching waterways; to assure maximum effectiveness of the nutrients on the soil; and to reduce the load of nutrients on waste treatment plants.

Conditions Where Practice Applies

This practice is applicable to all areas where fertilizers are used to enhance vegetative growth in order to stabilize disturbed land.

Planning Considerations

Generally, fertilizer runoff has been thought to be primarily an agricultural problem. However, because of the concentration of activities and the size of areas disturbed, construction sites have been found to be a major source of fertilizer runoff, thus significantly affecting water quality.

When excessive nutrients from fertilizers reach the waterways, they may result in oxygen depletion and over-stimulation of algal growth. In extreme cases, this causes eutrophication and/or stagnation of watercourses, that may require costly corrective measures over a long period of time.

Reduction of fertilizer runoff will help maintain the quality of nearby streams. Proper fertilizer application not only protects the waterways, but also holds the fertilizer in its intended place (on the soil) and ultimately saves the user money.

SPECIFICATIONS

Erosion Control

Soil stabilization techniques are necessary to prevent fertilizer nutrients from washing off vegetated areas. Straw mulch, chemical soil stabilizers and degradable ground covering fabrics are examples of measures that can be used (see sections on Mulching, and Temporary and Permanent Seeding).

Fertilizer Application Control (FAC) (Cont'd)

Timing of Application

The kind of turf being maintained will determine the time for fertilizing. Cool season turf (the fescues and bluegrass) should be fertilized in the fall and winter. Warm season grasses (Bermudas and Zoysias) should be fertilized in the spring and summer.

For best results make a soil test and apply only the nutrients needed by the plants. This reduces expense of unneeded fertilizer and reduces potential excess nutrient loss through runoff and leaching. Applying fertilizer under dry weather conditions can result in salt injury to the vegetation. A heavy rainfall just after fertilization will result in heavy runoff of nutrients. Therefore, it is best to fertilize when there is already adequate soil moisture and little likelihood of immediate heavy rain.